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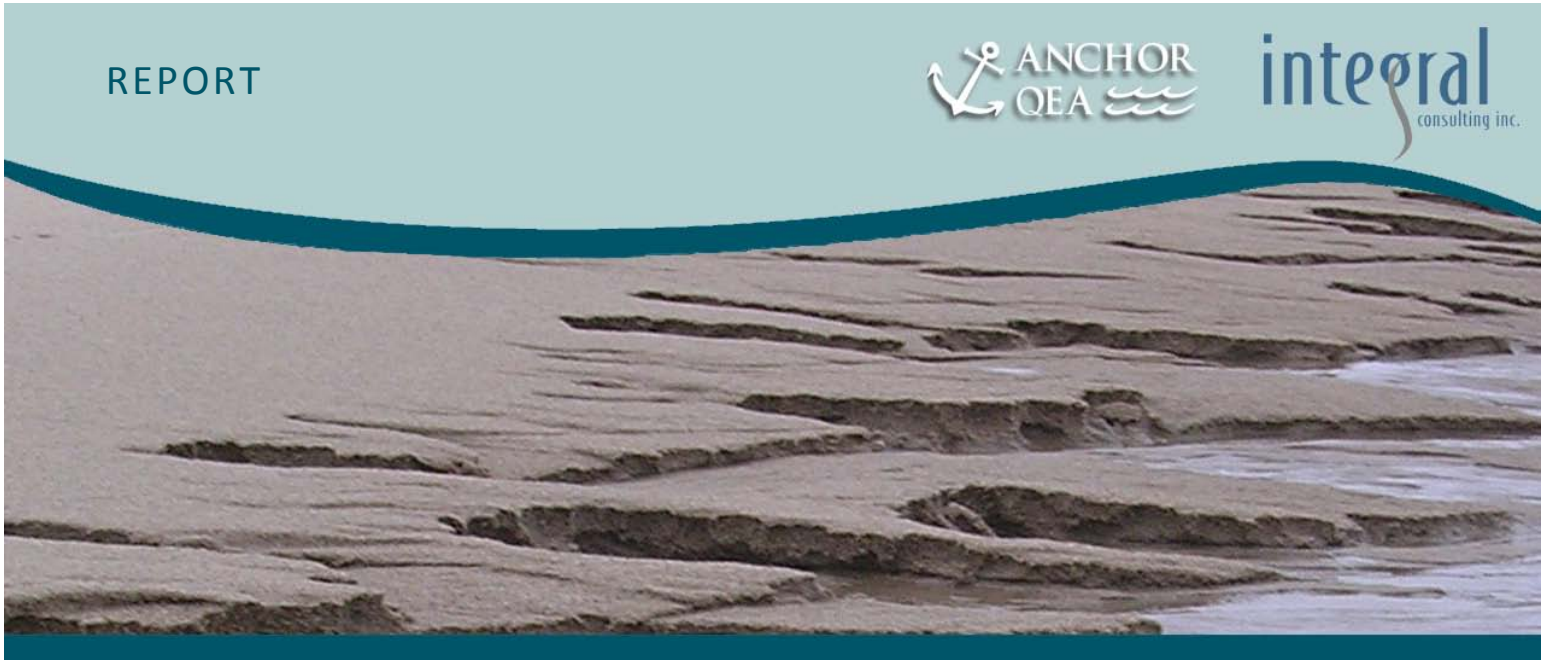

DRAFT—TECHNICAL MEMORANDUM ON BIOACCUMULATION MODELING
SAN JACINTO RIVER WASTE PITS SUPERFUND SITE

Prepared for

McGinnes Industrial Maintenance Corporation
International Paper Company
U.S. Environmental Protection Agency, Region 6

Prepared by

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June 2010

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LIST OF ACRONYMS AND ABBREVIATIONS

Abbreviation	Definition
2009 UAO	2009 Unilateral Administrative Order
Ah-R	aryl hydrocarbon receptor
AICc	Akaike information criterion adjusted for small sample size
BCF	bioconcentration factor
BERA	baseline ecological risk assessment
BHHRA	baseline human health risk assessment
BMF	biomagnifications factor
BSAF	biota-sediment accumulation factor
COPC	chemical of potential concern
D/F	polychlorinated dibenzo-*p*-dioxin and polychlorinated dibenzofuran
dioxin and furan	polychlorinated dibenzo-*p*-dioxin and polychlorinated dibenzofuran
DOC	dissolved organic carbon
HSC	Houston Ship Channel
IPC	International Paper Company
K_{ow}	octanol-water partition coefficient
MIMC	McGinnes Industrial Maintenance Corporation
MLR	multiple linear regression
PBPK	physiologically-based pharmacokinetic (model)
PCB	polychlorinated biphenyl
PCDD/F	polychlorinated dibenzo-*p*-dioxin and polychlorinated dibenzofuran
PRG	Preliminary Remediation Goal
RI/FS	Remedial Investigation/Feasibility Study
SAP	Sampling and Analysis Plan
Site	San Jacinto River Waste Pits site in Harris County, Texas
SJRWP	San Jacinto River Waste Pits
TCEQ	Texas Department of Environmental Quality

TDSHS	Texas Department of State Health Services
TEQ	toxicity equivalent
TMDL	Total Maximum Daily Load
TOC	total organic carbon
USEPA	U.S. Environmental Protection Agency
ww	wet weight

1 INTRODUCTION

This technical memorandum on bioaccumulation modeling was prepared on behalf of International Paper Company (IPC) and McGinnes Industrial Maintenance Corporation (MIMC; collectively referred to as the respondents) in fulfillment of the 2009 Unilateral Administrative Order (2009 UAO), Docket No. 06-03-10, issued by the U.S. Environmental Protection Agency (USEPA) to IPC and MIMC on November 20, 2009 (USEPA 2009), for the San Jacinto River Waste Pits (SJRWP) site in Harris County, Texas (the Site). The 2009 UAO directs the respondents to perform a Remedial Investigation/Feasibility Study (RI/FS) for the Site. A technical memorandum on modeling is required by the 2009 UAO if modeling is considered to be appropriate to meet the goals of the RI/FS Work Plan (Anchor QEA and Integral 2010). This technical memorandum, along with the Sampling and Analysis Plan (SAP) Addendum on chemical fate and transport modeling (SAP addendum), fulfills this requirement. These documents are intended to supplement the RI/FS Work Plan by describing the modeling efforts to be undertaken in support of achieving the overall RI/FS goals.

1.1 Purpose

This technical memorandum provides relevant technical background information to support the study design for collection and chemical analyses of tissue at the Site. It is a companion document to the Draft SAP for the Tissue Study at the Site (Tissue SAP; Integral 2010). Information on tissue chemistry is required by the RI/FS for human health and ecological risk assessment, and for development of risk-based Preliminary Remediation Goals (PRGs). The baseline ecological risk assessment (BERA) and baseline human health risk assessment (BHHRA) for the Site require information on the concentrations of chemicals of potential concern (COPCs) in the tissue of ecological receptors, including those that are or could be ingested by people. In addition, a quantitative relationship between COPC concentrations in sediment and biological tissues will form the basis of risk-based sediment PRGs. The Tissue SAP describes the overall rationale and methods for tissue data collection. This Technical Memorandum describes the methods that will be used to identify quantitative relationships between COPC concentrations in sediment and tissue, and provides the technical rationale to support selection of specific methods for the proposed analyses.

1.2 Risk Assessment Background

Appendix C of the Draft RI/FS Work Plan (Anchor QEA and Integral 2010) describes the methods and rationale for selection of COPCs for the RI/FS, and for designation of a chemical as a primary COPC or secondary COPC. The list of primary and secondary COPCs to be evaluated by the risk assessments for the Site includes dioxins and furans, polychlorinated biphenyls (PCBs), mercury, and other chemicals that may bioaccumulate in biological tissue. According to the RI/FS Work Plan, primary COPCs will be addressed by the BERA and BHHRA; secondary COPCs may be considered in the risk assessments if their concentrations in surface sediment do not correlate with those of dioxins and furans, but they fail to pass risk-based screening. For a COPC to be included in the risk evaluations, empirical information on the chemical concentrations in tissue, or the means to estimate tissue concentrations, will be required. As described in the Tissue SAP, all primary COPCs, and those secondary COPCs selected for evaluation in the risk assessments, will be measured in tissue samples from the Site. As a result, risk assessment for all of the COPCs to be evaluated can be addressed by site-specific empirical information on COPC concentrations in tissue.

Appendix C of the RI/FS Work Plan also establishes the use of dioxins and furans as an indicator chemical group for the Site, a concept provided for in USEPA guidance on performance of RI/FSs at CERCLA sites (USEPA 1988). This designation was made because dioxins and furans are persistent, are likely the most toxic chemicals at the Site, and are likely to contribute most significantly to overall risk at the Site. Use of dioxins and furans as an indicator chemical helps to focus the required analyses, reducing the time required to develop and evaluate remedial alternatives.

Because dioxins and furans are the indicator chemical group for the Site, and are most likely to be the chemicals that drive risk and therefore remedy selection, they are the focus of this memorandum. The toxicity of coplanar PCBs is considered by many to be additive with dioxins and furans, so PCBs may play a role in evaluation of remedial alternatives; they are therefore also addressed to some extent by this memorandum. If the RI/FS ultimately requires that concentrations of other COPCs in biological tissue be modeled, the methods described in this document, and the empirical information developed in the sediment study and the tissue study, can be used to develop site-specific relationships for those other COPCs.

The BHHRA and BERA will incorporate information on several different types of tissue from the Site, including whole molluscs (soft tissue), edible crab muscle tissue, whole fish, fish muscle (i.e., fillet), for which new empirical data will be generated (see the Tissue SAP), and bird eggs, which are useful for assessing risk to birds that are exposed to dioxins and furans but will not be collected and analyzed. Risks may be related to COPC concentrations in any of these types of tissue. For any tissue with levels of contamination resulting in unacceptable risks to people or ecological receptors, the relationship of tissue to sediment COPC concentrations will be evaluated to derive appropriate risk-based PRGs. This technical memorandum provides an evaluation of available modeling methods, analysis of selected data, and summary of key literature relating to bioaccumulation of dioxins and furans in the tissues of immediate interest to the RI (whole fish, whole benthic macroinvertebrates, fish muscle tissue, bird eggs, and edible crab tissue). The following specific topics are addressed:

- Available methods to relate chemical concentrations in tissue to concentrations in sediment
- Existing data on dioxins and furans in tissue for the Site and vicinity
- Biological and physical controls on bioaccumulation of dioxins and furans
- Conclusions and the selected method for predicting dioxins and furans in tissue.

This technical memorandum does not provide a comprehensive data evaluation or comprehensive review of the literature on dioxin and furan bioaccumulation.

2 OVERVIEW OF METHODS TO RELATE SEDIMENT AND TISSUE CONCENTRATIONS

Several different methods, of varying complexity, can be used to analyze and to represent the relationships between chemical concentrations in sediment and in tissue. These methods are:

- Ratios (i.e., a BSAF)
- Regression analyses
- Physiologically-based pharmacokinetic (PBPK) models
- Food web models.

2.1 Ratios

Ratios are the simplest possible representation of the relationship between chemical concentrations in sediment and in tissue. Ratios are calculated as the concentration in the tissue of interest, divided by the concentration in a single exposure medium, which may be sediment, water, or food. Examples of commonly used ratios are the bioconcentration factor (tissue/water; BCF), biota-sediment accumulation factor (tissue/sediment; BSAF), and the biomagnification factor (tissue/prey, BMF). Underlying their use is the assumption of a strictly proportional relationship between concentrations in the two media. Although ratios are widely used, this assumption of proportionality is rarely demonstrated to be justified despite the fact that it can be evaluated in all but the smallest data sets. The BSAF for organic chemicals is frequently computed after standardizing tissue data to the tissue lipid content and sediment data to the sediment organic carbon content. Standardizing one measured (i.e., imprecise) variable by another measured variable will magnify the uncertainty of the result unless the variables are strongly correlated (Bevington and Robinson 1992). In practice, a strong correlation is typically assumed to exist, and the appropriateness of data standardization is ordinarily not considered or demonstrated. Thus, although simple to calculate and understand, ratios tend to oversimplify complex phenomena, and incorporate several key assumptions that should be tested before the ratios are used to derive sediment PRGs or support remedial decisions or risk analyses.

2.2 Statistical Regression Analysis

Regression analysis of concentrations in tissue and sediment is a straightforward method using well-established statistical procedures. It can be considered to be a generalization of the ratio method: ratios are equivalent to regression equations with the intercept forced to zero. While remaining conceptually simple, regression analysis has several advantages over ratios, specifically the ability to incorporate non-zero intercepts, to incorporate the effects of multiple covariates such as lipid and organic carbon without making assumptions about covariance, to encompass non-linear relationships, and to produce a statistically sound measure of uncertainty. As a strictly empirical method, regression analysis does not require any information on the mechanisms of exposure and uptake, and thus can be applied to the sort of site characterization data typically collected in an RI/FS.

2.3 Pharmacokinetic Models

PBPK models represent bioaccumulation by individual tissues within an organism rather than by the organism as a whole. To achieve this level of detail requires a considerable amount of information about the physical and physiological mechanisms of exposure and of binding, transport, and sequestration in different tissues. Although PBPK modeling has the potential to produce very detailed estimates of bioaccumulation, allowing differentiation, for example, between edible and non-edible tissues, the data requirements of this method far exceed the information typically available from an RI/FS and for most ecological receptors.

2.4 Food Web Models

Food web models represent the mechanisms of initial chemical uptake at the lowest level of a food chain and subsequent chemical transfers to higher trophic level organisms through ingestion. They can also incorporate uptake via respiration. By explicitly modeling differing diet components as well as the effect of physiological mechanisms on uptake, metabolism, and excretion of compounds, food web models can potentially trace indirect pathways of contaminants from sediment to higher trophic level organisms. Like PBPK models, food web models require considerable amounts of information to construct, and to calibrate and validate for any given site. The simplicity of the result can mask the extent of the assumptions, and suggest a high level of precision and accuracy in predictions that are, in reality, quite uncertain. Food web models can be applied in either a dynamic or steady-state scenario. A dynamic food web model would allow changes in tissue contaminant concentrations to be modeled throughout the lifetime of a receptor organism. Because dynamic food web models have greater information requirements than steady-state models, steady-state applications are more common. The output of steady-state models, however, ordinarily reduces to a fixed relationship between concentrations in receptor tissue and sediment. Such a relationship could also be represented by a ratio or regression analysis.

2.5 Recommended Modeling Approach

Because regression analysis has several technical advantages over simple ratios, including an explicit characterization of model uncertainty, it is considered the most appropriate method for analysis and characterization of sediment-tissue relationships that may be required for the RI/FS. Statistical regression modeling can be carried out with data typically developed

during a site investigation. Data collected during previous investigations in the San Jacinto River and Houston Ship Channel (HSC) provide a useful information resource for regression analysis, if future sampling and analysis methods are comparable to those used for existing data for the Site. Regression analysis has been used to evaluate sediment–tissue relationships for dioxins and furans in this system using the existing data, as described in the next section.

3 ANALYSIS OF SITE-SPECIFIC DATA

As described in the Tissue SAP (Integral 2010), there are two primary sources of existing data on dioxin and furan concentrations in tissues from the Site and the surrounding areas. The geographic scope of these data sets includes upstream areas, downstream areas within the San Jacinto River, and the Buffalo Bayou portion of the HSC. These two data sources are:

- The Texas Department of Environmental Quality (TCEQ) Total Maximum Daily Load (TMDL) program for dioxins
- The Texas Department of State Health Services (TDSHS) monitoring data used for issuing fish consumption advisories and for performing various health evaluations associated with fish consumption in the San Jacinto River, HSC, and Galveston Bay.

The TCEQ TMDL program has measured dioxins and furans (as well as PCBs) in sediment, water, and tissue for a consistent set of species over several years and a broad geographic area, capturing a wide range of dioxin and furan exposure concentrations (University of Houston and Parsons 2006). The TDSHS program provides data for some of the same species monitored by TCEQ, and covers the same general area but with less frequent sampling and limited data for abiotic media. Summaries of these data, including chemical detection frequencies, numbers of samples, and the species sampled, are provided in Section 2 of the RI/FS Work Plan (Anchor QEA and Integral 2010) and in Section 1.4 of the Tissue SAP (Integral 2010).

For the analyses described below, the data generated from these two programs in 2000 or later, for catfish and blue crabs, were analyzed to characterize the patterns in the relative concentrations of dioxin and furan congeners in tissues, and to determine whether statistical regression could be used to develop useful empirical models for the congeners and tissues represented in the TCEQ and TDSHS data sets. Although there are some data for other

species and tissues, the blue and hardhead catfish fillet and the edible blue crab tissue data were selected for analyses because there is a well-developed data set for these tissues, these species have a close association with sediments, and they are used by people for recreational and commercial fisheries. Using the available sediment and water chemistry data, and the selected subset of the available tissue data, the following analyses were performed:

- Comparison of the relative mass (proportions) of individual dioxin and furan congeners in water and sediment to those in biological tissue
- Evaluation of sediment-tissue and water-tissue relationships using
  - Univariate correlation statistics
  - Multiple linear regression (MLR) analysis

There has been one study published that reports on chemical concentrations in eggs of birds collected from within the vicinity of the Site (Frank et al. 2001); the findings of that study are also discussed in this section.

3.1 Data Treatment and Analysis Methods

Concentrations of the seventeen 2,3,7,8-substituted aryl hydrocarbon-receptor (Ah-R) active dioxin and furan congeners in sediment, water, and tissue from the TMDL or the TDSHS data sets were used in this evaluation (Table 1). Sediment and tissue chemistry data were prepared by averaging field duplicates and laboratory splits, and using one-half the detection limit for those results that were below detection limits. Additional exploratory analyses and data preparation steps were performed, as described in Section 3.1.2. Dioxin and furan patterns (fingerprints) were calculated for each sample by dividing the concentration of each individual congener by the total concentration of all congeners. The fingerprints calculated as such are referred to and depicted henceforth as congener fractions or proportion of the cumulative total congener concentration for each sample.

3.1.1 Characterization of Exposure Units

Blue crab, hardhead catfish, and blue catfish are all mobile species, so their exposure to sediment dioxins and furans may not be well represented by a single sediment sample collected at the same location that the tissue was collected. Actual exposures may be better

represented by multiple sediment samples near the location where the tissue was collected. To address this exposure scenario, a spatially averaged sediment concentration was generated to evaluate sediment-tissue relationships for these species, in which concentrations for all sediments collected within a specified area, corresponding to the size of the exposure unit, were averaged to derive the exposure concentration. In the absence of unequivocal data for species-specific home ranges, several different sizes of areas were evaluated to determine the appropriate sediment exposure unit for each organism. Sediment data were spatially averaged for assumed home ranges (exposure units) ranging in radius from 10 to 5,000 m, and correlations of tissue and spatially-averaged sediment concentrations of individual dioxin and furan congeners were calculated. The size of the exposure unit with the highest correlation coefficient for each organism was used for subsequent analyses.

This analysis indicated that the strongest relationship between dioxins and furans in tissue and sediment was found with an exposure area (radius) of 100 m for blue crab and 1,000 m for catfish. In blue crabs, the males travel limited distances, remaining close to freshwater while females migrate to marine environments to spawn.[1] Given that the data are for mixed-sex crab samples, the results of the statistical analysis provide the most appropriate means to characterize the home range for the purposes of the exposure assessment. The calculated exposure unit of 1,000 m for catfish is consistent with home ranges of closely related catfish species reported by Daugherty and Sutton (2005). All subsequent analyses were performed using sediment data averaged for the species-specific exposure units according to these results. Calculations of exposure unit size for surface water cannot be approached with the same model used for sediments, because water is a dynamic physical system. The relationship between tissue and water concentrations were therefore evaluated using water and tissue samples collected from the same location at the same time.

3.1.2 Univariate and Multivariate Statistical Evaluation

To evaluate the degree to which any individual variable could explain tissue concentrations of dioxins and furans, the strength and significance of correlations between sediment and tissue and surface water and tissue concentrations of each congener individually were

[1] Blue Crab Life Cycle: http://www.bluecrab.info/lifecycle.html

evaluated using Kendall's tau-b, which is a correlation statistic suitable for censored data sets such as those that contain non-detects (Helsel 2005).

Multivariate statistics can quantify both the presence and the concentrations of multiple chemicals at a station and their potential relationships to biological effects. To identify potential relationships between tissue and sediment concentrations of dioxins and furans, while simultaneously considering ancillary variables, MLR was conducted. Potential covariates investigated using this method included total organic carbon (TOC) in sediment, tissue lipid content, and season. This approach is consistent with that employed by Dean et al. (2009). Because equivalent covariates were not measured in surface water (e.g., dissolved organic carbon, colloids), MLR was not conducted for this matrix.

To perform the MLR, the following steps were required to prepare the data, and then to conduct the analysis:

1. Data were transformed (Johnson et al. 2007) to approximate the necessary assumptions of multivariate normality. Data were tested with the Shapiro-Wilk goodness–of-fit tests following these transformations and deviations from normality were found to be minimal:
    a. For each analyte and sample matrix, multiple transformation procedures were investigated: natural log, log-base 10, square root, and Box-Cox.
    b. The best transformation was selected on the basis of results from the Shapiro-Wilk test and normal quantile regressions.
2. Exhaustive MLR
    a. Regression models were fit between tissue concentrations and every combination of dioxin and furan congeners in sediment, TOC, tissue lipid content, and season (as a categorical variable), including up to third order interactions terms.
    b. The best model was chosen using the Akaike information criterion adjusted for small sample size (AICc) fit statistic (Burnham and Anderson 2002).

All of the analyses were performed using R for Windows v. 2.10.1 (R Development Core Team 2009).

3.2 Relative Concentrations of Dioxins and Furans in Exposure Media and Tissue

In each exposure medium and tissue, the concentration fraction of each congener was calculated. Patterns of dioxins and furans in most sediment and water samples were dominated by a large proportion of OCDD (~87 percent). A few onsite samples had notable fractions of TCDD (~20 percent) and TCDF (~40 percent). In contrast, concentrations of dioxins and furans in blue crab tissue had notable fractions of TCDD (~14 percent), OCDD (~27 percent), TCDF (~27 percent), and OCDF (~15 percent), whereas each of the remaining 13 dioxin and furan congeners represented less than 1.5 percent of the total mass of all congeners in crab tissue (Table 2). The differences between the proportional contribution of each dioxin and furan congener in edible crab tissue, sediment, and surface water samples are illustrated in Figure 1 using examples from four areas widely distributed across the HSC system: upstream of the Site (~6 miles), in the immediate vicinity of the impoundments on the Site, downstream of the Site towards Galveston Bay (~6 miles), and upstream in the Buffalo Bayou (~15 miles). A substantial proportion of the total dioxins and furans in spatially isolated, distant crab tissue samples is represented by TCDD and TCDF, independent of the presence and abundance of these two congeners in co-located sediment and water samples (Figure 1).

Tissue concentrations of dioxins and furans in catfish had large proportions of OCDD (~25 percent), TCDD (~28 percent), and OCDF (~14 percent), whereas each of the remaining 14 dioxin and furan congeners represented less than 2 percent of the total concentrations in the catfish tissue samples (Table 3). There is a wider range of patterns of dioxins and furans in catfish compared to crab tissue. For example, dioxin patterns observed in a few fish tissue samples were dominated by OCDF (> 90 percent; e.g., Station 11258 in Buffalo Bayou and Station 13337 in Galveston Bay, Appendix A), while others by TCDD (> 40 percent; e.g., Stations 11252 and 11265, Appendix A). As noted, most sediment and water samples were dominated by a large proportion of OCDD (> 85 percent) (Table 3). The lack of concordance between the dioxin and furan patterns in fish tissue and those in sediment and water is illustrated in Figure 2 by examples from four areas widely distributed across the HSC system: upstream (~6 miles), in the immediate vicinity, downstream (~6 miles) of the impoundments, and upstream in Buffalo Bayou (~15 miles). Data for the stations shown in Figure 2 were

selected as a representative illustration of the general trends in dioxin and furan patterns in tissue, sediment, and water samples. Based on the investigation of the entire data set, and illustrated by the samples shown in Figure 2, we conclude that TCDD represented a substantial proportion of the total PCDD/Fs in catfish collected from spatially isolated areas, and the relative abundance of this congener was independent of the presence and relative abundance of this congener in collocated sediment and water samples.

3.3 Relationships of Blue Crab Tissue with Sediment and Surface Water

The differences in dioxin/furan patterns in different media, as summarized in the previous section, indicate that the relationship between dioxin/furan concentrations in tissue and environmental media varies both by species and by congener. These relationships have been investigated and characterized using both univariate and multivariate statistics.

Univariate correlations between sediment and crab tissue for individual congeners (Figures 3 to19, Table 4) indicate that only TCDD and TCDF have meaningful relationships[2] between their respective concentrations in sediment and crab tissue, having relatively high values for tau-b that were statistically significant. The other congeners had weak (< 0.3) or no correlation (Table 4). Significant relationships between surface water and crab tissue were observed only for TCDD and TCDF (Table 5). The other congeners did not show a significant correlation.

All eight congeners with significant univariate correlation between sediment and crab tissue (Table 4) were further investigated using MLR analysis. The best fitting models (based on AICc) for dioxin and furan concentrations in crab tissue are summarized in Table 6. Consistent with results of the univariate correlations analysis, TCDD and TCDF were the congeners with the strongest relationship between crab tissue and sediment, as indicated by the R-square values. However, even the best fitting models left approximately 45 percent of the variance unexplained. Both TOC and tissue lipid content were significant covariates. Interestingly, the best-fit models for both TCDD and TCDF do not contain the sediment concentrations as first-order terms, but rather only their interactions with sediment organic carbon, tissue lipid content, and season (Table 6). This suggests that sediment dioxin and

[2] Significant association ($p \leq 0.05$) with a tau-b > 0.3 (roughly equivalent to ~10 percent variance explained)

furans cannot be directly related to concentrations in crab tissue (i.e., as a ratio) with this data set, potentially because tissue concentrations are significantly modulated by additional factors. Only a small fraction of the variance in the tissue concentrations of the other dioxin and furan congeners could be predicted by sediment variables in the MLR analysis. These results are consistent with those reported by Dean et al. (2009).

3.4 Relationships of Catfish Fillet Tissue with Sediment and Surface Water

Univariate correlations between sediment and catfish fillet tissue (Figures 20 through 36, Table 7) show that only TCDD and TCDF have meaningful relationships. The other congeners either had weak (<0.3), negative relationships or did not show a correlation at all (Table 7). In contrast, the univariate correlations between surface water and catfish fillet tissue were generally poor (Table 8), although the highest values for tau-b were again for TCDD and TCDF. Even though four congeners had statistically significant correlations (TCDD, OCDD, TCDF, and 2,3,4,7,8-PeCDF), they were much weaker than the corresponding correlations observed for sediment. There were no significant correlations between water and catfish tissue for the remaining 13 congeners (Table 8).

The MLR analysis was used to further investigate sediment-tissue relationships only for those congeners with significant univariate correlations, i.e., TCDD and TCDF (Table 7). The best fitting models (based on AICc) for TCDD and TCDF concentrations in catfish fillet are summarized in Table 9. Paralleling the univariate correlations analysis, even the best fitting models left more than 40 percent of the variance unexplained. In the case of catfish fillet tissue, significant contributors to the explanatory power of the model were season, TOC, and tissue lipid content. These results are also consistent with those reported by Dean et al. (2009), who analyzed hardhead catfish data, even though they did not perform spatial-averaging of sediment concentrations (exposure units) that could be derived from the data (Section 3.1.1). As for the MLR results with crab tissue, the best-fit model for TCDF did not contain sediment concentration as a first-order term, but only the interaction terms with sediment organic carbon, catfish tissue lipid content, and season (Table 9).

3.5 Dioxin and Furan Concentrations in Bird Eggs

Frank et al. (2001) evaluated concentrations of multiple persistent organic pollutants in waterbird eggs in the Galveston Bay area. Several chemicals considered persistent by the authors, including selected dioxins and furans and PCBs, had been detected in fish and other organisms in the area, prompting this analysis of their concentrations in birds and an evaluation of potential adverse effects on birds. In addition to these areas sampled within Galveston Bay, two reference areas were included for comparison of levels of chemicals in eggs and adverse health effects, but dioxin and furan data for eggs are not reported from these locations. Alexander Island was the sampling location closest to the Site.

Eggs were collected from three bird species: neotropic cormorants (n = 28 eggs from four sites; n = 18 eggs from two reference sites), black-crowned night herons (n = 9 eggs only from Alexander Island), and great egrets (n = 7 eggs from one site). Eggs evaluated from the two reference areas were from cormorants only. The contents of the eggs were analyzed for concentrations of pesticides, PCBs, and dioxins and furans. This study is summarized in greater detail in the RI/FS Work Plan (Anchor QEA and Integral 2010); the discussion in this document addresses the PCB and the dioxin and furan residues found in these egg samples.

Among the dioxin and furan congeners, Frank et al. (2001) reported finding only 2,3,7,8-TCDD in the majority of egg samples, with 2,3,7,8-TCDF at concentrations above detection limits only in the eggs of one species, the black-crowned night heron. One of the three night heron eggs for which dioxin and furan data are reported also had measureable concentrations of 1,2,3,7,8-PeCDD, and 1,2,3,6,7,8-HxCDD, both of which were present at higher concentrations than 2,3,7,8-TCDF, but much lower than 2,3,7,8-TCDD.

The mean 2,3,7,8-TCDD in eggs of neotropic cormorants from Alexander Island (106 ng/kg ww) was higher than the mean from other areas sampled: Smith Point (10 ng/kg ww), and further downstream, Vingt-et-un (14 ng/kg ww). Dioxin and furan data for eggs from reference areas outside of Galveston Bay and the HSC were not reported. The means of 2,3,7,8-TCDD in eggs of the other species from Alexander Island were 163 ng/kg (black-crowned night heron) and 56 ng/kg ww (great egret).

3.6 Conclusions of Site-Specific Data Analyses

Several features are observed in the relationships between sediment, water, and tissue data for the Site and vicinity:

- The mixture of the 17 dioxin and furan congeners in the majority of sediment samples was dominated by OCDD, except in localized areas of the HSC where sediments are dominated by OCDF, or by TCDD and TCDF (at the Site).
- The proportions of the total dioxin and furan concentrations consisting of TCDD and TCDF were higher than those of other congeners in crab and fish tissue, even in locations where their proportions were not high in sediment or surface water. The differences between the relative importance of TCDD and TCDF in tissue from those of sediment and water were generally consistent in areas upstream of the Site in the San Jacinto River, at the Site, 6 miles downstream towards Upper Galveston Bay, and far upstream in Buffalo Bayou.
- Univariate correlations between sediment and tissue were strongest for TCDD and TCDF in both fish and crab tissue, although the sediment-tissue correlation for TCDF in catfish was poor (tau-b $\leq$ 0.30).
- Univariate correlations between water and tissue were generally weak for both crab and fish, but were consistent with those for sediment and tissue for TCDD and TCDF in both tissue types. The strength of the correlation of tissue TCDF with water was about twice as high for crab as it was for catfish fillet. Water-tissue correlations for the remaining congeners in both tissue types were somewhat weaker than their respective correlations between sediment and tissue.
- MLR models indicated that variation in tissue dioxin and furan concentrations is only partially explained by variation in sediment concentrations within the data set evaluated. Among the significant models, those for TCDD and TCDF explained from 46 to 57 percent of the variability in the edible crab or catfish fillet tissue data set. MLR models for other congeners were possible for crab, but were weak.
- In bird eggs collected from Alexander Island and analyzed for dioxins and furans, only 2,3,7,8-TCDD and 2,3,7,8-TCDF were present at detectable levels in the majority of egg samples, and 2,3,7,8-TCDF was present only in eggs of black-crowned night heron. Other congeners detected in just one black crowned night heron egg were 1,2,3,7,8-PeCDD, and 1,2,3,6,7,8-HxCDD, both of which were present at higher

concentrations than 2,3,7,8-TCDF, but much lower than 2,3,7,8-TCDD. Variation of 2,3,7,8-TCDD concentrations in bird eggs could not be explained by differences in diet (i.e., trophic level) among the birds, but variation in total PCBs was explained by differences in diets.

The dioxin and furan patterns in fish and crab tissue, as well as their differences relative to sediment and surface water, are consistent with literature for sites in other geographic areas, suggesting that the concentrations of these compounds in tissue may be more dependent on biological factors than on environmental factors and exposure conditions. For example, data presented by Naito et al. (2003) for the average concentrations of dioxin and furan congeners in sediments in Tokyo Bay (Japan) showed dioxin and furan patterns very similar to those in the HSC, with a dominant contribution from OCDD. Like HSC tissue samples (Figures 1 and 2), dioxin and furan concentrations in fish and invertebrate tissue in Tokyo Bay had a much higher relative contribution of the tetrachlorinated congeners than did the underlying sediment (Figure 37). In another study from Lake Ontario (Niimi 1996), patterns of the average concentrations of dioxin and furan congeners in trout (Figure 38) were very similar to those observed in catfish tissue within the HSC (Figure 2), whereas the corresponding sediment was still dominated by OCDD, although with somewhat higher contributions of OCDF than the average HSC sediments (compare Figures 2 and 38). Furthermore, mean concentrations of dioxins and furans in mysids (*Mysis relicta*, a shrimp-like crustacean in the same subphylum and class as blue crab) from Lake Ontario were highly enriched in TCDD and TCDF compared to sediments (Figure 38), which resulted in a pattern very similar to that observed for blue crab tissue throughout the HSC (Figure 1). The same overall trend has also been documented in Dungeness crab (*Cancer magister*) in British Columbia, Canada (Yunker and Cretney 2000) and in a range of aquatic organisms in Australia (Gatehouse 2004).

In addition, the Site-specific MLR results had lower explanatory power than observed with similar models for other organic chemicals with comparable properties, indicating that the bioaccumulation of dioxins and furans has limitations that do not affect bioaccumulation of other hydrophobic organic compounds. Two comprehensive reviews of the most commonly cited bioaccumulation models (Barber 2003 and 2008) tested model performance against a common database of sediment and aquatic biota concentrations for a series of hydrophobic

and lipophilic organic compounds (though not specifically dioxins). Barber (2003; 2008) concluded that most models tested had comparable performance in their ability to explain 65 to 69 percent of the variance in tissue concentrations, even though none met the criteria of a perfect model[3] (Barber 2003). In contrast, the best MLR model for the Site-specific data explained only 57 percent of variance in catfish fillet concentrations of TCDD (more than 10 percent loss of explanatory power).

In birds, dioxin and furan concentrations were not higher in eggs of those birds presumed to occupy higher trophic levels (Frank et al. 2001), which contrasts with patterns of other chemicals. For example, Frank et al. (2001) reported that the mean of total PCBs in neotropic cormorant eggs (at 5,700 µg/kg) was 2.7 times that of the mean total PCBs in black-crowned night heron eggs (2,100 µg/kg) and 3.7 times greater than the mean of total PCBs in eggs of great egret. The authors explain these differences in total PCB concentrations in eggs as the result of differences in feeding habits, with cormorants considered assumed to ingest generally larger fish than the other birds sampled. This explanation is consistent with a broad sampling of the literature. It is notable that the increase in total PCBs according to the relative trophic positions of the birds is not mirrored in the pattern in 2,3,7,8-TCDD in eggs from Alexander Island, where the black-crowned night heron not only has the highest mean 2,3,7,8-TCDD concentration in eggs, but has the only detectable amounts of other congeners. This lack of concordance between trophic position of birds and dioxin and furan concentrations is consistent with data presented by other studies in which birds have been addressed (Wan et al. 2005; Broman et al. 1992; Jarman et al. 1997). These studies find that 2,3,7,8-TCDD and 2,3,7,8-TCDF are often among the most prominent among the dioxin and furan congeners in bird tissues, but there is a lack of strong evidence to support patterns of biomagnification among dioxin and furan congeners that is similar to those seen for PCBs, DDT compounds, methylmercury, and other hydrophobic organic chemicals. The literature also provides clear evidence that most other dioxin and furan congeners do not increase in bird tissues with increasing trophic position.

To understand the reasons for the discrepancy between source and tissue concentrations and the similarity of dioxin and furan patterns in biological samples from sites across the globe

[3] Zero (0) intercept and unit (1) slope.

requires closer consideration of the physical, chemical, and biological mechanisms controlling concentrations of these substances in tissue.

4 CONTROLS ON DIOXIN BIOACCUMULATION

In the simplest terms, chemical bioaccumulation is governed by three processes: uptake, elimination, and biotransformation. Organism growth can also affect the final concentration of a chemical in tissue when the magnitude of exposure is variable over time (Barber 2008). The rates of these processes, particularly uptake and elimination, for hydrophobic organic compounds are thought to be controlled by their solubility in water relative to solubility in lipids. This relationship is commonly, but indirectly characterized in the laboratory by measuring a compound's octanol-water partition coefficient (K_{ow}). However, Opperhuizen and Sijm (1990) observed that bioaccumulation of dioxins and furans by fish departs from predictable patterns common to a majority of hydrophobic organic compounds, such as PCBs, polychlorinated naphthalenes, polybrominated biphenyls, and halogenated benzenes. These authors demonstrate that although the log K_{ow} is useful for predicting elimination rates and bioaccumulation coefficients for other halogenated organics, dioxins and furans to have higher elimination rates, lower bioconcentration factors, and lower biomagnification factors than expected on the basis of the log K_{ow}. Opperhuizen and Sijm (1990) propose that simple first-order kinetic bioaccumulation models are appropriate for the hydrophobic organic compounds that follow relationships predictable from log K_{ow}, but are not sufficient to explain the bioaccumulation of dioxins and furans.

Literature addressing bioaccumulation of dioxins and furans in aquatic systems describes a diversity of processes and biochemical pathways that control the uptake, elimination and biological transformation of dioxins and furans by exposed aquatic organisms (Opperhuizen and Sijm 1990; Niimi 1996; Loonen et al. 1997; Hu and Bunce 1999; Nichols et al. 1998). Rates of controlling processes vary by congener and by the species exposed. Absorption following oral exposure is "variable, incomplete, vehicle-dependent, and congener and species specific" in vertebrates and the efficiency of uptake across the gill may be dose-dependent (Hu and Bunce 1999). Limits on bioavailability also affect bioaccumulation rates in aquatic biota. As a result, patterns of bioaccumulation of the 17 dioxins and furans in aquatic invertebrates, fish, and birds are diverse, and mechanisms controlling all of the

observed patterns are not fully explained by the literature. In addition, the literature provides more experimental data for fish than for other taxa, likely because fish are relatively easy to manipulate in the laboratory. Information on fish provides insights into patterns for other aquatic species (i.e., those with gills), while experimental evidence to explain bioaccumulation of dioxins and furans in birds is substantially more limited. This section briefly highlights those observations that are consistently reported, and that help to explain the patterns in the Site-specific data discussed in Section 3. A conceptual framework to guide future evaluations is proposed.

4.1 Fish and Aquatic Invertebrates

In a recent publication, Barber (2008) reviewed, tested, and compared multiple performance metrics for a set of 16 widely cited bioaccumulation models using both empirical data for multiple fish species[4] and simulations. The study concluded that for highly hydrophobic compounds (log K_{ow} > 6.5) such as dioxins and furans, bioaccumulation parameters (e.g., absorption efficiency, elimination rates) should not be treated simply as constants or functions of K_{ow}. Fish body weight, rates of feeding and growth, exposure duration, and metabolism all play important roles in bioaccumulation, especially for compounds with very low bioavailability (Barber 2008). Although Barber (2008) did not directly address dioxins and furans, the limited bioavailability of these compounds to aquatic biota is well documented in the literature (Opperhuizen and Sijm 1990; Hu and Bunce 1999; Niimi 1996) and may be partly explained on the basis of molecular size (Opperhuizen and Sijm 1990) and partly by the strong association of dioxins with sediment (Loonen et al. 1997).

Uptake of dioxins and furans by aquatic organisms can occur both through respiration across the gills and from the gastrointestinal tract following ingestion. Tissue membrane permeability provides a key control on uptake rates of different congeners, and the more specialized gill membranes are less permeable than digestive membranes (Opperhuizen and Sijm 1990). Observed limitations on intestinal absorption in fish are similar to those in mammals (Hu and Bunce 1999), but the relative importance of the different exposure routes in fish is unresolved (Niimi 1996). Generally, it appears that absorption of the higher-

[4] Barber (2008) used a data set of multiple organic chemicals, their properties (e.g., K_{ow}), and their concentrations in several fish species, sediments, and diets, including studies from natural and laboratory settings.

chlorinated PCDD/Fs is slower than for lower chlorinated congeners across both tissue types, because larger molecules pass through the pores in the cell membranes of most organisms more slowly (or not at all) than smaller molecules (Opperhuizen and Sijm 1990). However, a pattern of lower dietary absorption with higher chlorination does not always hold for dioxin congeners following oral exposures (Niimi 1996; Tietge et al. 1998). Although dietary absorption efficiencies for dioxins and furans are thought to be generally poor, averaging about 0.2 (Niimi 1996), experimental data for actual dietary assimilation rates are limited for most dioxin and furan congeners. Reported assimilation efficiencies for 2,3,7,8-TCDD vary widely among fish species, ranging from 0.13 to 0.89, with juvenile fish observed to have lower assimilation rates of this congener (Tietge et al. 1998).

In fish, hepta- and octachlorinated dioxin uptake from the gastrointestinal tract is inefficient (Hu and Bunce 1999), but may be more so across the gills (Opperhuizen and Sijm 1990). Dietary uptake efficiencies of 2,3,4,7,8-PeCDF (0.41 to 0.44) and 2,3,7,8-TCDF (0.48 to 0.62) are lower than those for 2,3,7,8-TCDD. In contrast, absorption efficiencies for PCBs range from above 0.6 to 0.9 in some fish (Niimi 1996)..

Vertebrate organisms can detoxify, solubilize, and excrete dioxins and furans by oxidation and/or conjugation to sugars or sugar-acid ligands. Hu and Bunce (1999) describe how the metabolism of dioxin and furan congeners by vertebrates forms soluble conjugates, allowing for their excretion. This finding is supported for fish by others (e.g., Kleeman et al. 1986). Metabolism of 2,3,7,8-TCDD and 2,3,7,8-TCDF is facilitated by CYP-1A enzymes in the liver, accounting for differential accumulation in muscle tissue compared to the enzyme-rich liver of trout (Hu and Bunce 1999; Tietge et al. 1998) and in zebrafish carcass relative to liver Heiden et al. 2005). Hu and Bunce (1999) further note that dioxins and their metabolites are not bound by plasma proteins, as are other organochlorines (e.g., PCBs), thus making them more readily excretable. Nichols et al. (1998), in calibrating a PBPK model using experimental results for brook trout, found evidence that diffusion-driven efflux of 2,3,7,8-TCDD across the gills was a major route of elimination during the depuration phase of the experiment, Thus, TCDD and TCDF appear to be slightly more readily absorbed by aquatic biota than higher chlorinated congeners, while the ability of fish to metabolize these congeners appears limited (Niimi 1996), but elimination through both gills and digestive tract play a role in determining body burdens. The combination of these processes results in

a PCDD/F composition dominated by TCDD and TCDF in aquatic organisms, irrespective of the patterns of dioxins and furans to which they were exposed.

A few publications reporting both experimental and observational results in invertebrates demonstrate that there are important similarities between invertebrates and fish, and some differences. As for fish, limitations on uptake and elimination resulting from differences in molecular size and solubility explain patterns of tissue concentrations in oligochaete worms. Loonen et al. (1997) demonstrated that the uptake rate of TCDD by oligochaetes from ingested sediment was comparable to dietary uptake rates reported for fish, while the uptake of OCDD from ingested sediment was 2 orders of magnitude lower. Uptake of OCDD from water was an order of magnitude lower in oligochaetes than uptake from water of TCDD, and was generally lower than uptake from water that has been observed in fish (Loonen et al. 1997). Loonen et al. (1997) attribute the differences in uptake rates between the two congeners to molecular size. The authors also conclude that ingestion of contaminated sediment by the worms resulted in measurable but relatively minor increases in the contamination of worm tissues over those resulting from water-only exposures, suggesting that the ingestion route may be relatively less important in oligochaetes than in vertebrates, or that sediment-associated dioxins are less bioavailable when ingested than food-associated dioxins. Loonen et al. (1997) also demonstrated that uptake by oligochaetes from sediment was lower when the first exposure to sediment occurred 21 months after sediments were mixed with the TCDD or OCDD, regardless of exposure route. Kono et al. (in press) reports that uptake and elimination rates in polychaetes also appear to be controlled by molecular size.

Differential elimination rates seen in clams by Brown et al. (1994) are not consistent with the observations in worms. In an experimental transfer of clams (*Mya arenaria*) from contaminated to clean environments, Brown et al. (1994) documented low rates of elimination of both 2,3,7,8-TCDD and 2,3,7,8-TCDF by clams, with the half-life of TCDF (111 days) more than two times that of TCDD (45 days). In contrast, relative elimination half-lives for the same two congeners in fish were inverted, with half-lives from 50 and 130 days for TCDD (and up to 2 years for some species) and 3 and 80 days for TCDF (Niimi 1996; Tietge et al. 1998). For the remaining congeners, elimination half-lives in fish were between 2 and 80 days with no relationship to degree of chlorination (Niimi 1996). Half lives for some

lower trophic level species were relatively low in comparison to those reported for fish, including 25–35 days for insects, 15–58 days for mussels, and down to 9–10 days for microcrustaceans (Niimi 1996). These observations shed light on the patterns of dioxins and furans in fish and crab tissue observed for the Site data, but also illustrate the diversity of variables controlling tissue concentrations in aquatic species..

4.2 Birds and Bird Eggs

The majority of literature on dioxin and furan bioaccumulation in birds is observational, reporting dioxin and furan concentrations in bird tissues following field studies where contamination of foods, sediment, and/or water with dioxins and furans is quantified. Experimental data quantifying rates of controlling processes were not found for this review. The literature that was reviewed suggests that controls on bioaccumulation of dioxins and furans in birds are in some cases consistent with those for mammals and fish, but there appear to be several patterns unique to birds, as follows:

- A limited set of congeners generally dominates dioxin and furan contamination of bird tissues; results of several studies for multiple species are summarized in Table 10.
- 2,3,7,8-TCDD is frequently detected in bird tissues, but other dioxin and furan are often present at higher concentrations (e.g., Jarman et al. 1997). Pentachlorinated dioxin and furan congeners may contribute significantly to the total toxicity (expressed as toxicity equivalents [TEQs]) of dioxin and furan mixtures in bird tissue (Choi et al. 2001).
- There may be differences among bird species in the degree to which any given congener is metabolized and excreted (Braun and Norstrom 1990; Kannan et al. 2001). For example, 1,2,3,7,8-PeCDF concentrations are relatively high in herring gull tissues, while 2,3,4,7,8-PeCDF has the relatively highest concentrations in cormorants (Kannan et al. 2001).
- A simple comparison of BMFs for 2,3,7,8-TCDF by Braun and Norstrom (1990) suggests that this congener is rapidly metabolized, resulting in a short half-life in the herring gull. This is in conflict with data from Korea for several birds in which 2,3,7,8-TCDF was present in all birds, and correlated with 2,3,7,8-TCDD in several species (Choi et al. 2001). Choi et al. (2001) attribute the difference from the results of Braun and Norstrom (1990) to differences in source amounts of TCDF. Both papers

present limited data to support broad statements on retention of 2,3,7,8-TCDF in birds.

- In a field study in Lake Ontario, Braun and Norstrom (1990) document egg-to-whole body ratios for multiple compounds, and although only nine dioxin and furan congeners were detected in birds, the egg-to-whole body ratios are larger for these chemicals than for other hydrophobic organics. Braun and Norstrom (1990) suggest that dioxins and furans are selectively retained in bird livers; they speculate that this could occur through a variety of chemical binding mechanisms within the bird livers. Because egg yolk lipids are formed in the livers of birds, selective retention of dioxins and furans in livers may have importance for maternal transfer. Braun and Norstrom (1990) observed that increasing chlorination was associated with higher binding in the liver and lower rates of transfer to eggs.
- Because PCBs biomagnify, the proportion of TEQs contributed by PCBs in birds is often much greater than the proportion contributed by dioxins and furans (Wan et al. 2005; Kannan et al. 2001). For example, Kannan et al. (2001) show dioxins and furans contribute just 2 to 3 percent of the total TEQ in cormorants and herring gulls exposed to multiple Ah-R active chemicals in the Great Lakes. Jarman et al. (1992) observed that PCB TEQs in eggs of peregrine falcons in California contributed about 85 percent of the total TEQ concentration. This result is also suggested by data from Frank et al. (2001) for birds using the HSC environment.

These patterns suggest that simple methods to predict concentrations in bird eggs from concentrations in other tissues (or in prey) can lead to significant error in predicted egg tissue chemistry. However, as indicated by the RI/FS Work Plan (Appendix B, Attachment B2), egg concentrations are an important means to evaluate risk to birds, an approach recommended by USEPA (2003). The assumptions and methods involved when predicting concentrations of dioxins and furans in tissues of birds should be well supported by the literature, and clearly acknowledged.

4.3 Food Web Biomagnification

Although dioxins and furans are clearly absorbed by organisms, and some congeners are relatively persistent in biota, there is substantial evidence that the 17 dioxin and furan

congeners do not biomagnify in aquatic and marine food webs; that is, they do not show a consistent increase with increasing trophic level. Research in Japan, China, the northern Baltic Sea region, and coastal California (Naito et al. 2003; Wan et al. 2005; Broman et al. 1992; and Jarman et al. 1997, respectively) using stable isotopes of nitrogen (^{15}N) to document food web structure, has demonstrated that concentrations of dioxins and furans do not increase with increasing trophic level; that is, they do not biomagnify in marine and freshwater food webs that include invertebrates, fish, and birds. These patterns are often in sharp contrast to the clear biomagnification of other hydrophobic chemicals such as PCBs. Moreover, statistical evaluations of relationships between trophic level (as $\delta^{15}N$) and BSAF indicate that concentrations of 2,3,7,8-TCDD and 2,3,7,8-TCDF in tissue are not significantly related to trophic level, but BSAFs for several other congeners do have significant relationships with trophic level that are negative (Naito et al. 2003; Wan et al. 2005). Results of other research that does not quantify the food web structure are consistent with these studies (Owens et al. 1994; Niimi 1996; Frank et al. 2001).

Even though BSAFs tend to oversimplify the bioaccumulation of dioxins and furans (Section 2), they can be broadly informative because they reflect a snapshot of the relative concentrations of an individual chemical in tissue to the concentration in an exposure medium. A sampling of published BSAFs from the peer-reviewed literature (not intended to be comprehensive) is presented in Table 11. TCDD and TCDF consistently appear to have higher BSAFs than the other PCDD/F congeners, but they were rarely much higher than 1, indicating a minimal potential for bioaccumulation from sediment. This is in contrast to the magnitude of BSAFs for PCBs, which were found to be at least one order of magnitude higher (even up to 4). These BSAFs also show that dioxin and furan congeners with five or more chlorine atoms almost always have BSAFs much less than 1, supporting a conclusion that these congeners do not biomagnify and have limited bioaccumulation.

The variability in rates of absorption, metabolism, and elimination among the dioxin and furan congeners help explain patterns of bioaccumulation: congeners with BSAFs having steep negative slopes with increasing trophic level are those that are not readily absorbed (Naito et al. 2003). Although 2,3,7,8-TCDD and 2,3,7,8-TCDF can be shown to bioaccumulate in the presence of an ongoing source, the ability of animals to metabolize and excrete these compounds, and limits on absorption help explain why the biomagnification

potential of these congeners is very limited. Rates of metabolism are not strictly predictable on the basis of degree of chlorination (Niimi 1996), but relative to other congeners, 2,3,7,8-TCDD and 2,3,7,8-TCDF have higher rates of absorption coupled with relatively low rates of metabolism and therefore are more persistent in biota than higher chlorinated congeners. As a result, their relative importance may seem to increase at higher trophic levels as other congeners are lost to biotransformation and excretion at a faster rate. This pattern may give the impression of biomagnification for these congeners, but is not equivalent to the biomagnification seen for other chemicals such as PCBs and methylmercury, for which increasing concentrations are observed in successively higher trophic levels.

4.4 Conceptual Framework for Dioxin and Furan Bioaccumulation

Uptake efficiencies vary by congener, exposure medium, exposure route, and species. The ability of organisms to transform and eliminate the different dioxin and furan congeners, and the differences in transformation and elimination rates for different congeners adds complexity to patterns of dioxin and furan bioaccumulation across the range of taxa to be evaluated for the SJRWP Site RI. The literature on these subjects is extensive, sometimes contradictory, and more often observational than experimental. A common conclusion in the literature, however, is that bioaccumulation is controlled more by physiological mechanisms than by chemical properties such as log K_{ow}. To guide the analysis of bioaccumulation patterns in tissues at the Site and in its vicinity, a conceptual framework based on those principles and patterns consistently observed and well-documented in the literature is needed. The following subsections summarize the discussion in Section 4 and represent our current understanding of the processes governing bioaccumulation of dioxins and furans in aquatic organisms, as a consensus of the themes from the peer-reviewed literature referenced therein.

4.4.1 Uptake

Many publications explore and evaluate dioxin and furan bioaccumulation, and limited uptake efficiencies consistently provide the best explanation for observed patterns in relative congener concentrations in various types of biological tissue. The following general patterns are consistent in the literature reviewed (e.g., Opperhuizen and Sijm 1990; Niimi 1996; Hu and Bunce 1999), and in the Site-specific data:

- Uptake of PCDD/Fs is congener-specific, both mechanistically and kinetically
- The ability of PCDD/Fs to be absorbed varies by molecular size, decreasing with increasing level of chlorination
- Higher-chlorinated PCDD/F molecules are large, limiting their ability to pass through the pores in cell membranes
- In fish and other aquatic organisms, uptake of PCDD/Fs is inefficient from both food and water
- Dietary uptake efficiencies of PCDD/Fs in fish are variable and consistently lower than those for PCBs

4.4.2 Biotransformation

Metabolism of dioxins and furans forms soluble conjugates that are readily eliminated, but rates of elimination differ among the congeners. Literature reviews (in particular Opperhuizen and Sijm 1990; Niimi 1996; and Hu and Bunce 1999) for vertebrates and some invertebrates provides the following important insights:

- Biotransformation of dioxins results in detoxification rather than bioactivation
- Metabolic rates of 2,3,7,8-TCDD appear to be low in fish; 2,3,7,8-TCDF is more readily metabolized in fish and mammals (Hu and Bunce 1999).
- Metabolism of PCDD/Fs in aerobic organisms proceeds through hydroxylation, ring opening, and conjugation to water-soluble ligands (Hu and Bunce 1999). Dechlorination of higher into lower-chlorinated congeners (reductive dechlorination) has been documented only in anaerobic bacteria.
- PCBs are also conjugated to water-soluble ligands, but their metabolites can become trapped by plasma proteins, resulting in lower elimination rates than observed for dioxins and furans.

4.4.3 Excretion

Elimination is the least well-described physiological process affecting dioxin/furan bioaccumulation. In vertebrates, mechanisms of elimination are closely tied to biotransformation of congeners to soluble conjugates. In aquatic invertebrates and fish,

elimination may be driven by variability in exposure, allowing for equilibration with ambient levels facilitated by transfer across the gills. General observations among vertebrates include (in particular Opperhuizen and Sijm 1990; Niimi 1996; and Hu and Bunce 1999):

- Excretion of absorbed PCDD/Fs is occurs as a result of biotransformation, which is congener specific
- PCDD/F metabolites are water-soluble and readily excretable
- Dioxin and furan metabolites are not bound by plasma proteins, making them more readily excretable than those of PCBs
- The poor absorption of PCDD/Fs from food makes the digestive system a net elimination route rather than uptake pathway for some congeners when organisms move from more highly contaminated environments to less contaminated environments.
- Half-lives of TCDD in fish vary widely across species, and may be greater than those for TCDF. In contrast, the half life for TCDF in clams was more than twice the half-life of 2,3,7,8-TCDD.

4.4.4 Uncertainties

There are significant uncertainties limiting specific prediction of tissue concentrations for all of the 17 dioxin and furan congeners of interest. The available data show a wide diversity of controlling processes and rates across the broad range of taxa to be addressed by the SJRWP RI. Bioaccumulation in birds is particularly poorly described in the published literature; and process rates for many of the congeners are lacking or poorly described. Efforts to predict concentrations of dioxins and furans in tissue must acknowledge the absence of key information and the discrepancies in the literature that result in uncertain predictions of tissue chemistry. Empirical data and analyses may provide more reliable guidance to risk managers than mechanistic modeling. Although the literature provides useful information to guide interpretation of the existing data for the Site and vicinity, the remaining uncertainties support the selection of empirically based, regression modeling as the appropriate means for bioaccumulation modeling

5 APPROACH TO MODELING TISSUE

On the basis of the data analyses and literature presented in this memorandum, estimates of concentrations of dioxins and furans in biological tissue should be developed using methods that are based on site-specific, empirical information, and that have an inherent recognition of the limits of verifiable assumptions and information. For these reasons, evaluation of site-specific multivariate statistical correlations, and development of regression models using site and regional data, is the most appropriate means for identifying and characterizing relationships between dioxin and furan concentrations in sediment and tissue. Statistical models implicitly recognize the limits of available information, and allow quantification of uncertainty in predictions. Moreover, since uptake, excretion, and metabolism are congener-dependent both in terms of mechanics and rates, bioaccumulation of PCDD/Fs cannot be understood on the basis of aggregate quantities, such as homolog groups or TEQ. Aggregate variables (such as TEQ) in exposure media should not be used to predict TEQ in tissue unless they can be verified for the species that are the subject of the prediction in the environment of interest, and if they provide a verifiably better means of prediction than congener-specific models using site-specific data.

Use of site-specific statistical regression models overcomes several weaknesses of other methods to predict tissue concentrations. Use of ratios oversimplifies the phenomenon of bioaccumulation and provides no means to characterize or document uncertainty. Food web models (Arnot and Gobas 1999) require estimates for several parameters that vary significantly among organisms and are not fully described. They are costly to construct, and calibration with site-specific data typically results in a model that is fitted to available measurements rather than being parameterized in a way that supports accurate predictions outside the range of observed data. Although the important role played by physiological processes indicates that pharmacokinetic modeling would be an appropriate approach to predict dioxin/furan bioaccumulation, the species-specific physiological data needed for this approach are simply not available. An absence of quantitative data for many controlling parameters precludes the application of complex PBPK models to predict tissue concentrations.

Although empirical models (e.g., regression analysis) have greater potential applicability to the Site than do mechanistic models, analysis of currently available data indicates that even

empirical models will explain only about half of the variation seen in tissue samples. Because of the attendant uncertainty, use of models to predict tissue concentrations of dioxin and furan congeners should generally be verified with empirical measurements where the predictions are important to risk management decisions.

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APPENDIX A
DIOXIN AND FURAN PROFILES FOR ALL CRAB AND FISH SAMPLES COLLECTED WITHIN THE HOUSTON SHIP CHANNEL

TABLES

Table 1
Seventeen Ah-R Active Dioxin and Furan Congeners Addressed in the Site-Specific Data Evaluation

2,3,7,8-Tetrachlorodibenzo-*p* -dioxin
1,2,3,7,8-Pentachlorodibenzo-*p* -dioxin
1,2,3,4,7,8-Hexachlorodibenzo-*p* -dioxin
1,2,3,6,7,8-Hexachlorodibenzo-*p* -dioxin
1,2,3,7,8,9-Hexachlorodibenzo-*p* -dioxin
1,2,3,4,6,7,8-Heptachlorodibenzo-*p* -dioxin
Octachlorodibenzo-*p* -dioxin
2,3,7,8-Tetrachlorodibenzofuran
1,2,3,7,8-Pentachlorodibenzofuran
2,3,4,7,8-Pentachlorodibenzofuran
1,2,3,4,7,8-Hexachlorodibenzofuran
1,2,3,6,7,8-Hexachlorodibenzofuran
1,2,3,7,8,9-Hexachlorodibenzofuran
2,3,4,6,7,8-Hexachlorodibenzofuran
1,2,3,4,6,7,8-Heptachlorodibenzofuran
1,2,3,4,7,8,9-Heptachlorodibenzofuran
Octachlorodibenzofuran

Notes

Ah-R = aryl hydrocarbon receptor

Table 2
Range of Concentrations for Ah-R Active Dioxin and Furan Congeners in Crab Tissue and Collocated Sediments and Water Samples

Analyte	Sediment (ng/kg dw)[a]			Surface Water (pg/L)			Crab Edible Tissue (ng/kg ww)		
	Min	Mean	Max	Min	Mean	Max	Min	Mean	Max
2,3,7,8-TCDD	0.125	12.4	139	0.900	28.7	215	0.0900	2.56	12.0
1,2,3,7,8-PeCDD	0.330	1.01	3.39	0.600	3.53	14.0	0.0500	0.227	1.50
1,2,3,4,7,8-HxCDD	0.110	2.12	5.89	0.900	5.38	19.0	0.0445	0.141	1.40
1,2,3,6,7,8-HxCDD	0.600	5.35	17.5	1.08	11.3	78.3	0.0550	0.239	1.80
1,2,3,7,8,9-HxCDD	0.290	4.11	11.1	1.15	13.2	42.0	0.0480	0.175	1.70
1,2,3,4,6,7,8-HpCDD	5.85	153	536	36.0	335	1860	0.150	0.786	3.00
OCDD	157	3350	9750	410	8000	43000	0.700	4.78	34.2
2,3,7,8-TCDF	0.0850	36.6	342	2.95	109	640	0.105	4.91	30.0
1,2,3,7,8-PeCDF	0.245	7.03	119	1.15	7.31	130	0.0550	0.277	2.85
2,3,4,7,8-PeCDF	0.130	7.57	145	0.850	9.08	68.5	0.0650	0.369	2.95
1,2,3,4,7,8-HxCDF	0.255	17.1	278	0.550	11.0	155	0.0465	0.266	4.45
1,2,3,6,7,8-HxCDF	0.130	5.31	89.3	0.700	7.03	90.0	0.0485	0.207	4.20
1,2,3,7,8,9-HxCDF	0.219	3.47	78.5	0.463	2.67	30.0	0.0495	0.243	7.00
2,3,4,6,7,8-HxCDF	0.205	2.96	34.0	0.850	5.27	62.0	0.0490	0.196	5.00
1,2,3,4,6,7,8-HpCDF	0.483	59.7	1300	0.650	46.8	1200	0.0600	0.474	6.63
1,2,3,4,7,8,9-HpCDF	0.195	6.77	145	0.750	5.56	95.5	0.0500	0.225	1.35
OCDF	2.70	1250	38500	6.45	448	21500	0.105	6.20	151

Notes

Ah-R = aryl hydrocarbon receptor

dw = dry weight

ww = wet weight

a - Summary statistics for sediment may differ from those in Table 3 due to differences in averaging sediment concentrations for the correlation analyses with crab according to the exposure unit derived for crab (Section 3.1.1).

Table 3

Range of Concentrations for Ah-R Active Dioxin and Furan Congeners in Catfish Fillets and Collocated Sediments and Water Samples

Analyte	Sediment (ng/kg dw)[a]			Surface Water (pg/L)			Catfish Fillet (ng/kg ww)		
	Min	Mean	Max	Min	Mean	Max	Min	Mean	Max
2,3,7,8-TCDD	0.125	63.9	1830	0.900	29.0	215	0.0550	5.31	27.0
1,2,3,7,8-PeCDD	0.262	2.09	37.7	0.600	3.49	14.0	0.0495	0.375	4.50
1,2,3,4,7,8-HxCDD	0.110	2.17	4.74	0.900	5.36	19.0	0.0460	0.246	6.80
1,2,3,6,7,8-HxCDD	0.362	5.27	17.5	1.08	11.3	78.3	0.0550	0.638	7.60
1,2,3,7,8,9-HxCDD	0.290	4.36	10.7	1.15	13.2	42.0	0.0495	0.302	7.50
1,2,3,4,6,7,8-HpCDD	6.53	152	536	36.0	335	1860	0.110	1.17	10.0
OCDD	157	3400	9750	410	8050	43000	0.590	3.59	17.0
2,3,7,8-TCDF	0.0850	183	5300	2.95	110	640	0.0500	0.580	8.40
1,2,3,7,8-PeCDF	0.245	12.6	297	1.15	7.33	130	0.0330	0.436	16.0
2,3,4,7,8-PeCDF	0.130	10.5	215	0.850	9.08	68.5	0.0600	0.692	17.0
1,2,3,4,7,8-HxCDF	0.255	25.9	582	0.550	11.1	155	0.0360	0.369	11.0
1,2,3,6,7,8-HxCDF	0.130	7.50	155	0.700	7.06	90.0	0.0325	0.553	7.80
1,2,3,7,8,9-HxCDF	0.219	3.66	63.3	0.463	2.66	30.0	0.0140	0.241	6.40
2,3,4,6,7,8-HxCDF	0.205	3.31	37.4	0.850	5.28	62.0	0.0145	0.225	7.50
1,2,3,4,6,7,8-HpCDF	0.483	42.3	535	0.650	47.1	1200	0.0230	0.429	9.00
1,2,3,4,7,8,9-HpCDF	0.195	5.73	61.0	0.750	5.59	95.5	0.0170	0.339	10.0
OCDF	3.10	626	16000	6.45	452	21500	0.165	7.74	230

Notes

dw = dry weight

ww = wet weight

a - Summary statistics for sediment may differ from those in Table 2 due to differences in averaging sediment concentrations for the correlation analyses with catfish according to the exposure unit derived for catfish (Section 3.1.1).

Table 4
Results of Univariate Correlation (tau-b) for Individual Dioxin and Furan Congeners in Sediment and Crab Edible Tissue

Analyte	tau-b	*p* -Value
2,3,7,8-TCDD	0.434	< 0.001
1,2,3,7,8-PeCDD	0.0401	0.447
1,2,3,4,7,8-HxCDD	0.0450	0.393
1,2,3,6,7,8-HxCDD	0.0517	0.329
1,2,3,7,8,9-HxCDD	-0.00204	0.970
1,2,3,4,6,7,8-HpCDD	0.168	0.00162
OCDD	0.149	0.00507
2,3,7,8-TCDF	0.465	< 0.001
1,2,3,7,8-PeCDF	0.255	< 0.001
2,3,4,7,8-PeCDF	0.282	< 0.001
1,2,3,4,7,8-HxCDF	0.141	0.00748
1,2,3,6,7,8-HxCDF	0.165	0.00181
1,2,3,7,8,9-HxCDF	0.0405	0.443
2,3,4,6,7,8-HxCDF	0.0677	0.199
1,2,3,4,6,7,8-HpCDF	0.0605	0.253
1,2,3,4,7,8,9-HpCDF	0.0638	0.227
OCDF	0.0149	0.780

Table 5
Results of Univariate Correlation (tau-b) for Individual Dioxin and Furan Congeners in Surface Water and Edible Blue Crab Tissue

Analyte	tau-b	*p* -Value
2,3,7,8-TCDD	0.433	< 0.001
1,2,3,7,8-PeCDD	-0.0283	0.713
1,2,3,4,7,8-HxCDD	-0.0340	0.657
1,2,3,6,7,8-HxCDD	-0.0306	0.692
1,2,3,7,8,9-HxCDD	-0.0979	0.199
1,2,3,4,6,7,8-HpCDD	0.0576	0.458
OCDD	0.152	0.0501
2,3,7,8-TCDF	0.516	< 0.001
1,2,3,7,8-PeCDF	0.144	0.0606
2,3,4,7,8-PeCDF	0.0952	0.216
1,2,3,4,7,8-HxCDF	0.0436	0.569
1,2,3,6,7,8-HxCDF	-0.0213	0.782
1,2,3,7,8,9-HxCDF	0.0113	0.884
2,3,4,6,7,8-HxCDF	0.0902	0.236
1,2,3,4,6,7,8-HpCDF	0.00333	0.968
1,2,3,4,7,8,9-HpCDF	-0.0536	0.481
OCDF	-0.00433	0.959

Table 6
Results of MLR Analyses for Ah-R Active Dioxin and Furan Congeners in Crab Edible Tissue

Analyte	Model Terms	Adjusted R^2	*p* -Value
2,3,7,8-TCDD	L	0.491	< 0.001
	Cs * L		
	TOC * L		
	Cs * S		
1,2,3,4,6,7,8-HpCDD	Cs * TOC	0.0620	0.00107
OCDD	Cs * L * S	0.122	< 0.001
2,3,7,8-TCDF	L	0.562	< 0.001
	S		
	Cs * L		
	L * S		
	Cs * TOC * L		
1,2,3,7,8-PeCDF	Cs	0.352	< 0.001
	Cs * TOC * L		
	Cs * TOC * S		
	Cs * L * S		
2,3,4,7,8-PeCDF	Cs * L	0.206	< 0.001
	Cs * S		
	Cs * L * S		
1,2,3,4,7,8-HxCDF	Cs	0.170	<0.001
	TOC * L		
	Cs * TOC * L		
	Cs * TOC * S		
1,2,3,6,7,8-HxCDF	Cs	0.0527	0.0167
	Cs * TOC * L		
	Cs * TOC * S		

Notes

Only congeners with significant univariate correlations were evaluated.

Cs = chemical concentration in sediment

L = lipid concentration

MLR = multiple linear regression

S = season

TOC = total organic carbon concentration

Table 7
Results of Univariate Correlation (tau-b) for Individual Dioxin and Furan Congeners in Sediment and Catfish Fillet

Analyte	tau-b	*p* -Value
2,3,7,8-TCDD	0.449	< 0.001
1,2,3,7,8-PeCDD	0.144	0.0295
1,2,3,4,7,8-HxCDD	0.0603	0.362
1,2,3,6,7,8-HxCDD	-0.0627	0.345
1,2,3,7,8,9-HxCDD	-0.0405	0.542
1,2,3,4,6,7,8-HpCDD	0.0295	0.658
OCDD	0.0469	0.482
2,3,7,8-TCDF	0.299	< 0.001
1,2,3,7,8-PeCDF	0.0192	0.771
2,3,4,7,8-PeCDF	0.193	0.00360
1,2,3,4,7,8-HxCDF	0.0435	0.506
1,2,3,6,7,8-HxCDF	0.0245	0.711
1,2,3,7,8,9-HxCDF	-0.0782	0.233
2,3,4,6,7,8-HxCDF	0.00280	0.968
1,2,3,4,6,7,8-HpCDF	-0.0467	0.476
1,2,3,4,7,8,9-HpCDF	-0.0506	0.440
OCDF	-0.191	0.00402

Table 8
Results of Univariate Correlation (tau-b) for Individual Dioxin and Furan Congeners in Surface Water and Catfish Fillet

Analyte	tau-b	*p* -Value
2,3,7,8-TCDD	0.357	< 0.001
1,2,3,7,8-PeCDD	-0.103	0.179
1,2,3,4,7,8-HxCDD	0.101	0.190
1,2,3,6,7,8-HxCDD	-0.0123	0.876
1,2,3,7,8,9-HxCDD	-0.0986	0.201
1,2,3,4,6,7,8-HpCDD	0.0376	0.628
OCDD	0.216	0.00516
2,3,7,8-TCDF	0.275	< 0.001
1,2,3,7,8-PeCDF	0.0503	0.512
2,3,4,7,8-PeCDF	0.203	0.00851
1,2,3,4,7,8-HxCDF	0.0376	0.621
1,2,3,6,7,8-HxCDF	0.0483	0.526
1,2,3,7,8,9-HxCDF	0.00699	0.930
2,3,4,6,7,8-HxCDF	0.0646	0.398
1,2,3,4,6,7,8-HpCDF	0.00666	0.933
1,2,3,4,7,8,9-HpCDF	0.00366	0.965
OCDF	-0.0526	0.498

Table 9
Results of MLR Analyses for Ah-R Active Dioxin and Furan Congeners in Catfish Fillets

Analyte	Model Terms	Adjusted R^2	*p* -Value
TCDD	Cs	0.570	< 0.001
	TOC		
	TOC * L		
	L * S		
	Cs * TOC * L		
	Cs * L * S		
TCDF	TOC	0.467	< 0.001
	TOC * L		
	Cs * TOC * L		
	Cs * L * S		

Notes

Only congeners with significant univariate correlations were evaluated.

Ah-R = aryl hydrocarbon receptor

Cs = chemical concentration in sediment

L = lipid concentration

MLR = multiple linear regression

S = season

TOC = total organic carbon concentration

Table 10

Dioxin and Furan Congeners Frequently Reported to Occur in Bird Tissue[a]

	Jarman et al. 1997		van den Berg et al. 1987	Braun and Norstrom 1990		Choi et al. 2001			
	Pigeon guillemot	**Brandt's cormorant**	**Great cormorant**	**Herring gull**		**Herring gull**	**Black-tailed gull**	**Little tern**	**Sanderling**
	eggs		**liver**	**whole body**	**eggs**	**subcutaneous fat**			
Analyte									
2,3,7,8-TCDD	x	X	X	X	X	x	X	X	X
1,2,3,7,8-PeCDD	X	X	X	X	X	X	X	X	X
1,2,3,4,7,8-HxCDD	x		--	--	--		x	x	
1,2,3,6,7,8-HxCDD	X	X	X	X	X	x	X	X	
1,2,3,7,8,9-HxCDD	x		--	--	--				
1,2,3,4,6,7,8-HpCDD	X	X	--	x	x				
OCDD	--	--	--	x	x				
2,3,7,8-TCDF	x	X	x	x		x	x	X	x
1,2,3,7,8-PeCDF	x	x	--	--	--	x	x	x	x
2,3,4,7,8-PeCDF	X	X	X	X	X	X	X	X	X
1,2,3,4,7,8-HxCDF	x		x[b]	x	x	x	x	x	
1,2,3,6,7,8-HxCDF			x[b]	x	x				
1,2,3,7,8,9-HxCDF			--	--	--				
2,3,4,6,7,8-HxCDF			--	--	--				
1,2,3,4,6,7,8-HpCDF			--	--	--				
1,2,3,4,7,8,9-HpCDF			--	--	--		x		
OCDF		X	--	--	--				

Notes

Blank cells indicate congener is below or near detection limit and a very small component of dioxins/furans present in tissue.

-- = No data reported for this congener; it is not clear whether tissue was not analyzed for the congener or whether it was analyzed and the congener was not detected.

x = Congener is relatively minor component of dioxins/furans present in tissue.

X = Congener is relatively major component of dioxins/furans present in tissue.

a - Data represent only a partial review of the literature.

b - Data provided for sum of congeners 1,2,3,4,7,8- and 1,2,3,6,7,8-HxCDF.

Table 11
Literature-Review Summary of Published BSAF Values for Dioxins, Furans, and PCBs in Aquatic Organisms

Reference	Congener	Species	BSAF	BSAF Units[a]	BSAF Type	Number of Samples	Sample Collection	Comments	Additional Comments
Crustaceans									
Yunker and Cretney 2000	2,3,7,8-TCDD	*Cancer magister* (Dungeness crab)	1.40		median hepatopancreas	55	Synchronous[b]	Also cited in Wakeman and Hoffman (2006).	
	1,2,3,7,8-PeCDD		0.850			82			
	1,2,3,6,7,8-HxCDD		0.330			105		Cretney and Yunker (2000) use the same data set	
	1,2,3,7,8,9-HxCDD		0.140			103		as presented here to look at the relationship	
	1,2,3,4,6,7,8-HpCDD		0.0500			97		between BSAFs and sediment concentrations.	
	OCDD		0.0100			77		Data from this study are not presented.	
	2,3,7,8-TCDF		1.90			106			
	1,2,3,7,8-PeCDF		0.670			57			
	2,3,4,7,8-PeCDF		0.900			59			
	1,2,3,4,7,8-HxCDF		0.240			30			
	1,2,3,6,7,8-HxCDF		0.160			23			
	2,3,4,6,7,8-HxCDF		0.170			22			
	1,2,3,4,6,7,8-HpCDF		0.0700			67			
	OCDF		0.00900			13			
Yunker and Cretney 2000	2,3,7,8-TCDD	*Cancer magister* (Dungeness crab)	2.40	ww % lipid conc/dw sediment OC conc	mean hepatopancreas	55	Synchronous[b]	Also cited in Wakeman and Hoffman (2006).	
	1,2,3,7,8-PeCDD		1.70			82			
	1,2,3,6,7,8-HxCDD		0.710			105		Cretney and Yunker (2000) use the same data set	
	1,2,3,7,8,9-HxCDD		0.320			103		as presented here to look at the relationship	
	1,2,3,4,6,7,8-HpCDD		0.100			97		between BSAFs and sediment concentrations.	
	OCDD		0.0700			77		Data from this study are not presented.	
	2,3,7,8-TCDF		4.00			106			
	1,2,3,7,8-PeCDF		1.60			57			
	2,3,4,7,8-PeCDF		1.60			59			
	1,2,3,4,7,8-HxCDF		0.880			30			
	1,2,3,6,7,8-HxCDF		0.490			23			
	2,3,4,6,7,8-HxCDF		0.380			22			
	1,2,3,4,6,7,8-HpCDF		0.190			67			
	OCDF		0.0300			13			
Segstro et al. 1995	1,3,6,8-TCDD	*Orconectes virilis* (crayfish)	0.680	lipid conc/sediment OC conc	mean after 1,484-1,499 day exposure period	4	--	Mean BSAFs calculated using sediment and biota concentrations at end of exposure period	
	OCDD		0.0700						
	1,3,7,9-TCDD		0.440						
	HpCDD		0.0300						
Segstro et al. 1995	1,3,6,8-TCDD	*Orconectes virilis* (crayfish)	0.530	lipid conc/sediment OC conc	mean after 1,484-1,587 day exposure period	4	--	Mean BSAFs calculated using sediment and biota concentrations at end of exposure period	
	OCDD		0.0900						
	1,3,7,9-TCDD		0.310						
	HpCDD		0.0400						
Segstro et al. 1995	2,3,7,8-TCDF	shrimp	0.610	lipid conc/sediment OC conc	mean after 0-28 day exposure period	--	--	Mean BSAFs calculated using sediment and biota concentrations at end of exposure period	Values cited using results from secondary source
	2,3,7,8-TCDD		0.730						
Gatehouse 2004	2,3,3',4,4'-PCB	crab	11.0	lipid conc/sediment OC conc		--	--	Sediment samples collected as near as possible to where organism was collected	
	2,3',4,4',5-PCB		4.30						
	2,3,3',4,4',5-HxCBP		7.00						
Molluscs									
Wakeman and Hoffman 2006	2,3,7,8-TCDD	*Saxidomus giganteus (b* utter clam)	0.433	lipid conc/sediment OC conc	mean	--	--	Authors cite BSAFs from Clarke et al. (2004)	
	1,2,3,7,8-PeCDD		1.13						
	1,2,3,4,7,8-HxCDD		1.28						
	1,2,3,6,7,8-HxCDD		0.211						
	1,2,3,7,8,9-HxCDD		0.514						
	1,2,3,4,6,7,8-HpCDD		0.0500						
	OCDD		0.0390						
	2,3,7,8-TCDF		0.899						
	1,2,3,7,8-PeCDF		1.09						
	2,3,4,7,8-PeCDF		0.550						
	1,2,3,4,7,8-HxCDF		0.288						

Table 11
Literature-Review Summary of Published BSAF Values for Dioxins, Furans, and PCBs in Aquatic Organisms

Reference	Congener	Species	BSAF	BSAF Units[a]	BSAF Type	Number of Samples	Sample Collection	Comments	Additional Comments
	1,2,3,6,7,8-HxCDF		1.11						
	2,3,4,6,7,8-HxCDF		0.463						
	1,2,3,7,8,9-HxCDF		0.623						
	1,2,3,4,6,7,8-HpCDF		0.0320						
	1,2,3,4,7,8,9-HpCDF		0.252						
	OCDF		0.0330						
Segstro et al. 1995	1,3,6,8-TCDD	*Anodonta grandis* (mussel)	29.0	lipid conc/sediment OC conc	mean after 0-10 day exposure period	--	--	Mean BSAFs calculated using sediment and biota concentrations at end of exposure period	Values cited using results from secondary source
	OCDD		4.70						
Segstro et al. 1995	1,3,6,8-TCDD	*Anodonta grandis* (mussel)	1.70	lipid conc/sediment OC conc	mean after 10-24 day exposure period	--	--	Mean BSAFs calculated using sediment and biota concentrations at end of exposure period	Values cited using results from secondary source
	OCDD		0.930						
	2,3,7,8-TCDF		4.70						
Segstro et al. 1995	1,3,6,8-TCDD	*Anodonta grandis* (mussel)	0.180	lipid conc/sediment OC conc	mean after 1,484-1,499 day exposure period	4	--	Mean BSAFs calculated using sediment and biota concentrations at end of exposure period	
	OCDD		0.100						
	1,3,7,9-TCDD		0.100						
	HpCDD		0.0700						
Segstro et al. 1995	1,3,6,8-TCDD	*Anodonta grandis* (mussel)	0.130	lipid conc/sediment OC conc	mean after 1,484-1,587 day exposure period	4	--	Mean BSAFs calculated using sediment and biota concentrations at end of exposure period	
	OCDD		0.0500						
	1,3,7,9-TCDD		0.0700						
	HpCDD		0.0300						
Segstro et al. 1995	2,3,7,8-TCDF	marine clam	0.660	lipid conc/sediment OC conc	mean after 0-120 day exposure period	--	--	Mean BSAFs calculated using sediment and biota concentrations at end of exposure period	Values cited using results from secondary source
	2,3,7,8-TCDD		0.930						
Gatehouse 2004	2,3,3',4,4'-PCB	clam	1.80	lipid conc/sediment OC conc		--	--	Information gathered from secondary source cited as Haruhiko et al. (2003).	
	2,3',4,4',5-PCB		0.900						
	2,3,3',4,4',5-HxCBP		3.50						
Fish									
Segstro et al. 1995	1,3,6,8-TCDD	white sucker	0.800	lipid conc/sediment OC conc	mean after 10-24 day exposure period	--	--	Mean BSAFs calculated using sediment and biota concentrations at end of exposure period	Value scited using results from secondary source
	OCDD		0.520						
Segstro et al. 1995	2,3,7,8-TCDF	carp	0.0600	lipid conc/sediment OC conc	mean after 0-55 day exposure period	--	--	Mean BSAFs calculated using sediment and biota concentrations at end of exposure period	Values cited using results from secondary source
	2,3,7,8-TCDD		0.270						
Segstro et al. 1995	2,3,7,8-TCDF	*Cyprinus carpio* (carp)	0.170	lipid conc/sediment OC conc	mean after 0-84 day exposure period	--	--	Mean BSAFs calculated using sediment and biota concentrations at end of exposure period	Values cited using results from secondary source
	2,3,7,8-TCDD		0.840						
Gatehouse 2004	2,3,3',4,4'-PCB	Herbivorous mudskipper	12.8	lipid conc/sediment OC conc		--	--	Information gathered from secondary source cited as Haruhiko et al. (2003).	
	2,3',4,4',5-PCB		3.20						
	2,3,3',4,4',5-HxCBP		4.70						
Gatehouse 2004	2,3,3',4,4'-PCB	Omnivorous mudskipper	15.5	lipid conc/sediment OC conc		--	--	Information gathered from secondary source cited as Haruhiko et al. (2003).	
	2,3',4,4',5-PCB		6.20						
	2,3,3',4,4',5-HxCBP		7.40						
Gatehouse 2004	2,3,3',4,4'-PCB	Omnivorous mudskipper	9.20	lipid conc/sediment OC conc		--	--	Information gathered from secondary source cited as Haruhiko et al. (2003).	
	2,3',4,4',5-PCB		4.80						
	2,3,3',4,4',5-HxCBP		6.60						
Gatehouse 2004	2,3,3',4,4'-PCB	Coastal water fish	2.00	lipid conc/sediment OC conc		--	--	Information gathered from secondary source cited as Haruhiko et al. (2003).	
	2,3',4,4',5-PCB		1.10						
	2,3,3',4,4',5-HxCBP		0.750						
Gatehouse 2004	2,3,3',4,4'-PCB	Squid	1.20	lipid conc/sediment OC conc		--	--	Information gathered from secondary source cited as Haruhiko et al. (2003).	
	2,3',4,4',5-PCB		0.300						
	2,3,3',4,4',5-HxCBP		2.50						
Gatehouse 2004	2,3,3',4,4'-PCB	Porpoise	65.0	lipid conc/sediment OC conc		--	--	Information gathered from secondary source cited as Haruhiko et al. (2003).	
	2,3',4,4',5-PCB		47.0						
	2,3,3',4,4',5-HxCBP		26.0						
Gatehouse 2004	TCDD	*Salvelinus namaycush* (lake trout)	0.0700	lipid conc/sediment OC conc	Mean	--	--	Information gathered from secondary source cited as USEPA (1993).	Lake-wide average for Lake Ontario
		Salmo trutta (brown trout)	0.0300						
		Perca flavescens (yellow perch)	0.0300						
		Morone americana (white perch)	0.200						

Table 11
Literature-Review Summary of Published BSAF Values for Dioxins, Furans, and PCBs in Aquatic Organisms

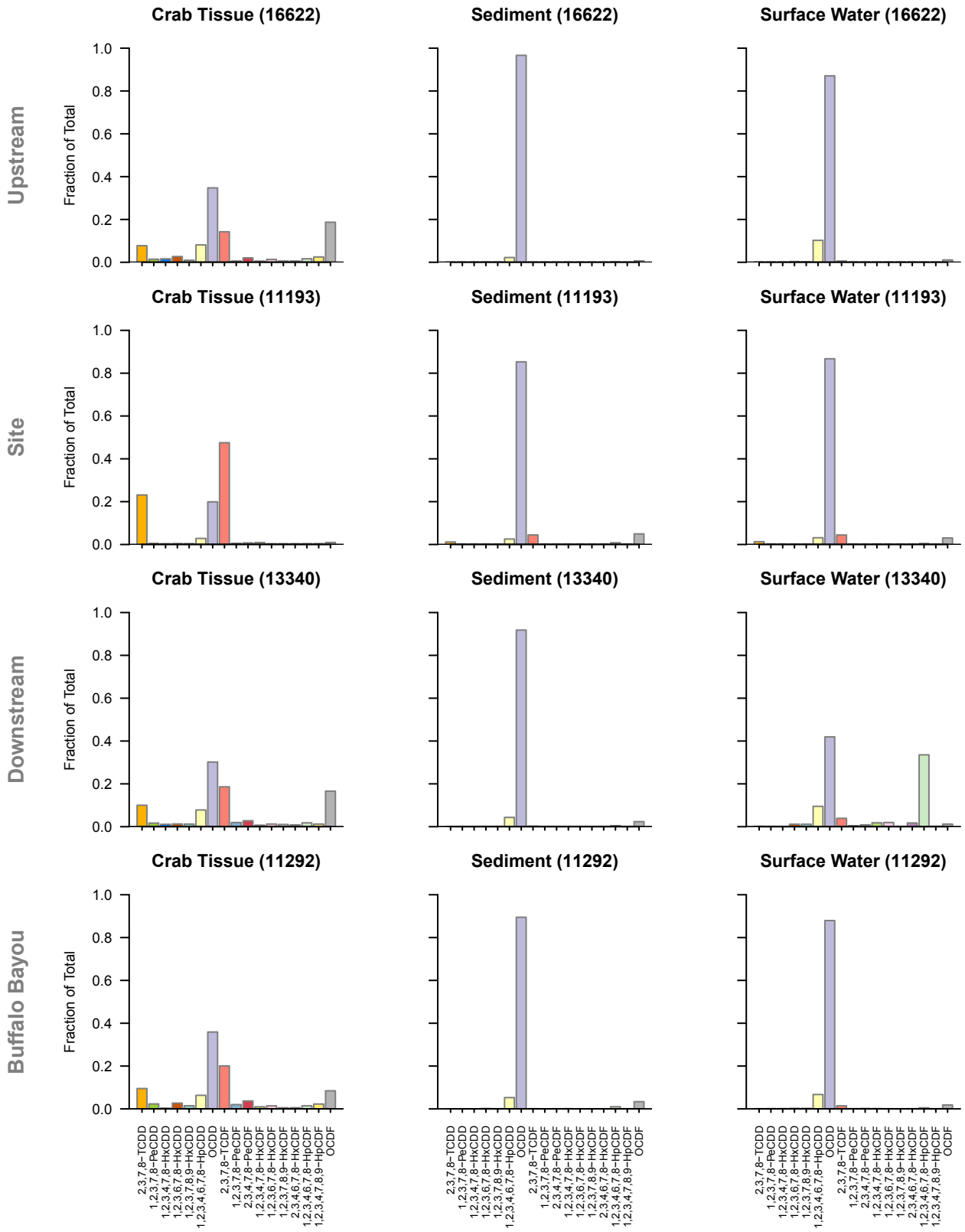
Reference	Congener	Species	BSAF	BSAF Units[a]	BSAF Type	Number of Samples	Sample Collection	Comments	Additional Comments
		Micropterus dolomieu (smallmouth bass)	0.0500						
		smelt	0.0600						
		Cottus cognatus (slimy sculpin)	0.120						
Gatehouse 2004	2,3,7,8-TCDD	*Micropterus salmoides* (largemouth bass)	0.0880-0.100	lipid conc/sediment OC conc		--	--	Information gathered from secondary source cited as Schell et al. 1993	Values are for TCDD in the liver of a composite sample of a field population
		Amia calva (bowfin)	0.180-0.260						
		Ictalurus bebulosus (brown bullhead catfish)	0.0400-0.0700						
Benthic Infauna									
Loonen et al. 1997	2,3,7,8-TCDD	*Lumbriculus variegatus* (worm)	0.990	lipid conc/sediment OC conc	mean BSAF after 28 days exposure following 21 months sediment incubation	4	Synchronous[c]	For BSAF calculations, the contribution of gut contents estimated from measurements after 2 days clearance was subtracted from observed concentrations at 28 days[d]	
	OCDD		0.0300			4			
Loonen et al. 1997	2,3,7,8-TCDD	*Lumbriculus variegatus* (worm)	1.60	lipid conc/sediment OC conc	mean BSAF after 28 days exposure following 3 weeks sediment incubation	3	Synchronous[c]	For BSAF calculations, the contribution of gut contents estimated from measurements after 2 days clearance was subtracted from observed concentrations at 28 days[d]	
	OCDD		0.0670			3			
Segstro et al. 1995	2,3,7,8-TCDF	*Hexagenia* nymphs	0.250	lipid conc/sediment OC conc	mean after 0-21 day exposure period	--	--	Mean BSAF calculated using sediment and biota concentrations at end of exposure period	Value cited using results from secondary source
Segstro et al. 1995	2,3,7,8-TCDF	*Hexagenia* nymphs	0.170	lipid conc/sediment OC conc	mean after 0-60 day exposure period	--	--	Mean BSAF calculated using sediment and biota concentrations at end of exposure period	Value cited using results from secondary source
Froese et al. 1998	Total PCB	Invertebrates (emergent *Chironomidae*)	11.0	lipid conc/sediment OC conc		--	Asynchronous[e]	Authors did not specify congeners	
		Tachycineta bicolor (tree swallow eggs)	8.80						
		Tachycineta bicolor (tree swallow nestlings)	9.30						
Froese et al. 1998	Non- + mono-*ortho* -PCBs	Invertebrates (emergent *Chironomidae*)	0.300	lipid conc/sediment OC conc		--	Asynchronous[e]	Authors did not specify congeners	
		Tachycineta bicolor (tree swallow eggs)	0.700						
		Tachycineta bicolor (tree swallow nestlings)	1.10						
Segstro et al. 1995	2,3,7,8-TCDF	Sandworm	0.250	lipid conc/sediment OC conc	mean after 0-180 day exposure	--	--	Mean BSAFs calculated using sediment and biota concentrations at end of exposure period	Value cited using results from secondary sourece
	2,3,7,8-TCDD		0.480						

Notes

-- = data not available.
BSAF = biota-sediment accumulation factor
conc = concentration
dw = dry weight
OC = organic carbon
ww = wet weight

a - Units are normalized lipid tissue concentration/OC normalized sediment or soil concentration.
b - Samples of crab hepatopancreas and sediment were taken from the same location and same sample collection trip.
c - Samples of worms and sediment were collected simultaneously from lab beakers.
d - Sediment was collected and treated to remove large debris and benthic organisms. Worms were introduced to the sediment in the lab at a later time.
e - Samples were collected in 1992 within the Saginaw Bay watershed, and included sediment, invertebrates, and tree swallow eggs and nestlings. Tree swallow eggs were chosen randomly from nests with 5 or more eggs, nestlings were euthanized at 15 days of age.

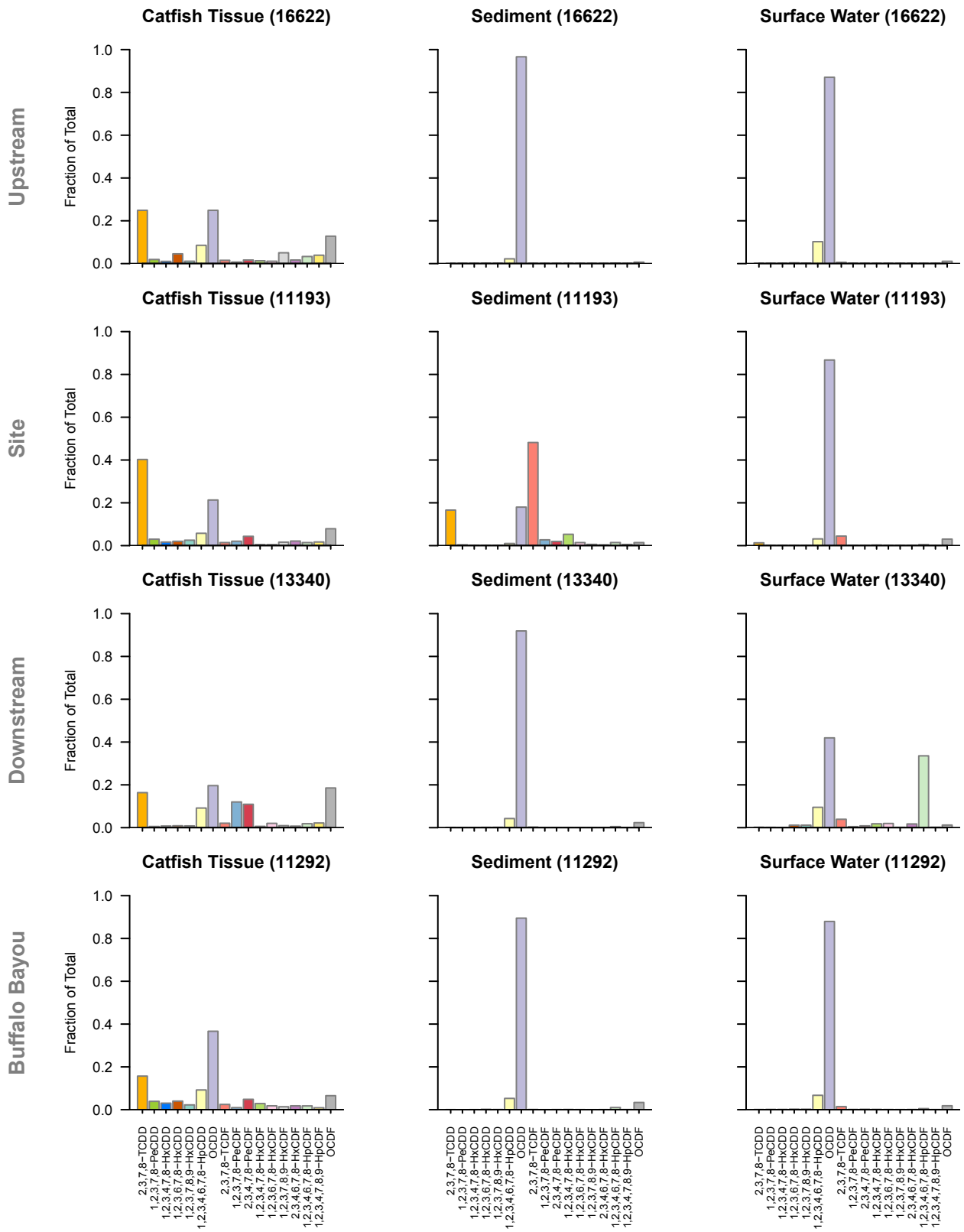
FIGURES



Note:
Sediment data were spatially averaged (100-m radius); colors are used only to assist visual comparisons and have no intrinsic meaning.

Figure 1
Relationship of D/F Patterns for Selected Collocated Samples of Edible Crab Tissue, Surface Water, and Surface Sediment
Bioaccumulation Technical Memo
SJRWP Superfund/MIMC and IPC

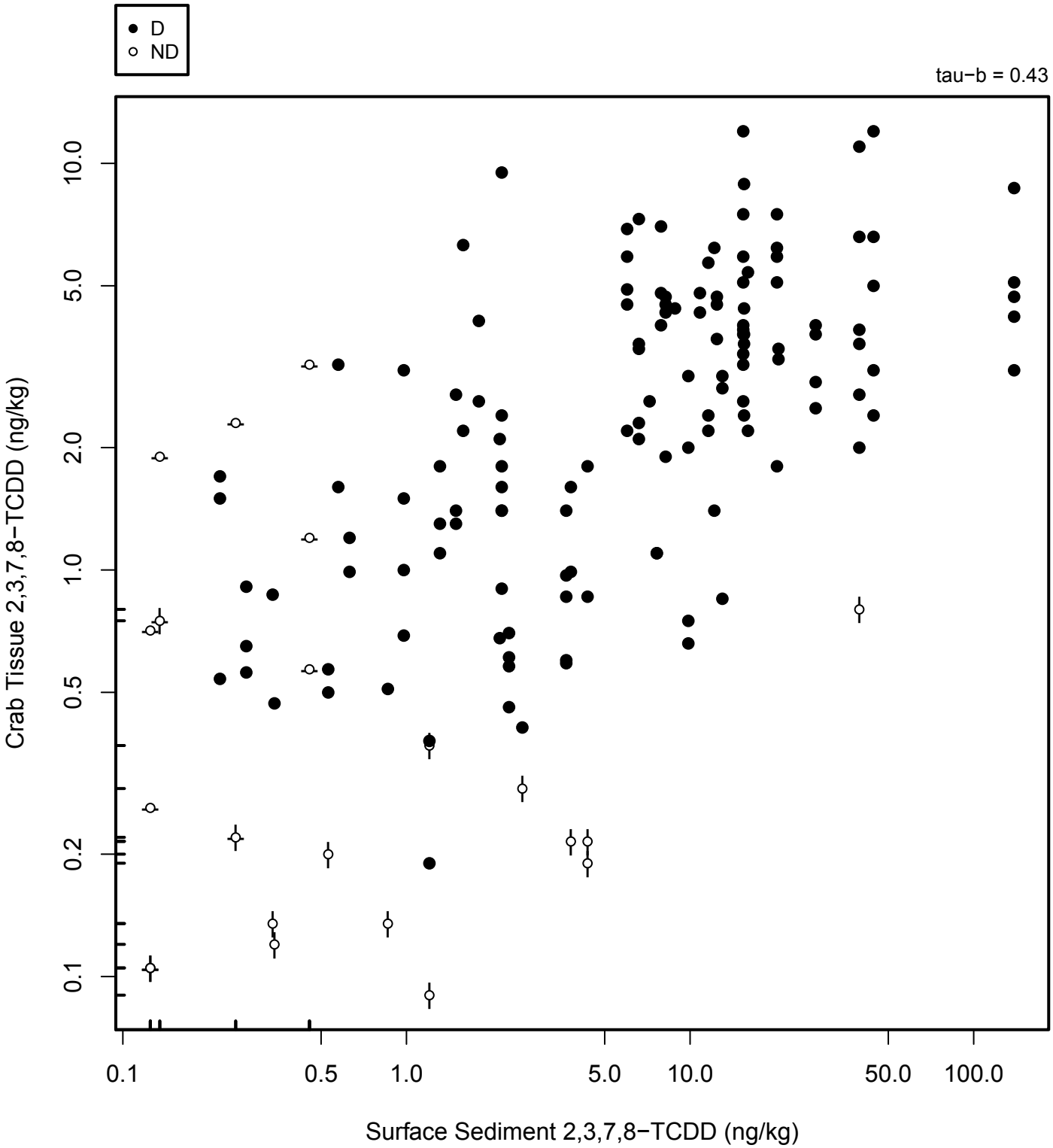
DRAFT



Note:
Sediment data were spatially averaged (1-km radius); colors are used only to assist visual comparisons and have no intrinsic meaning.

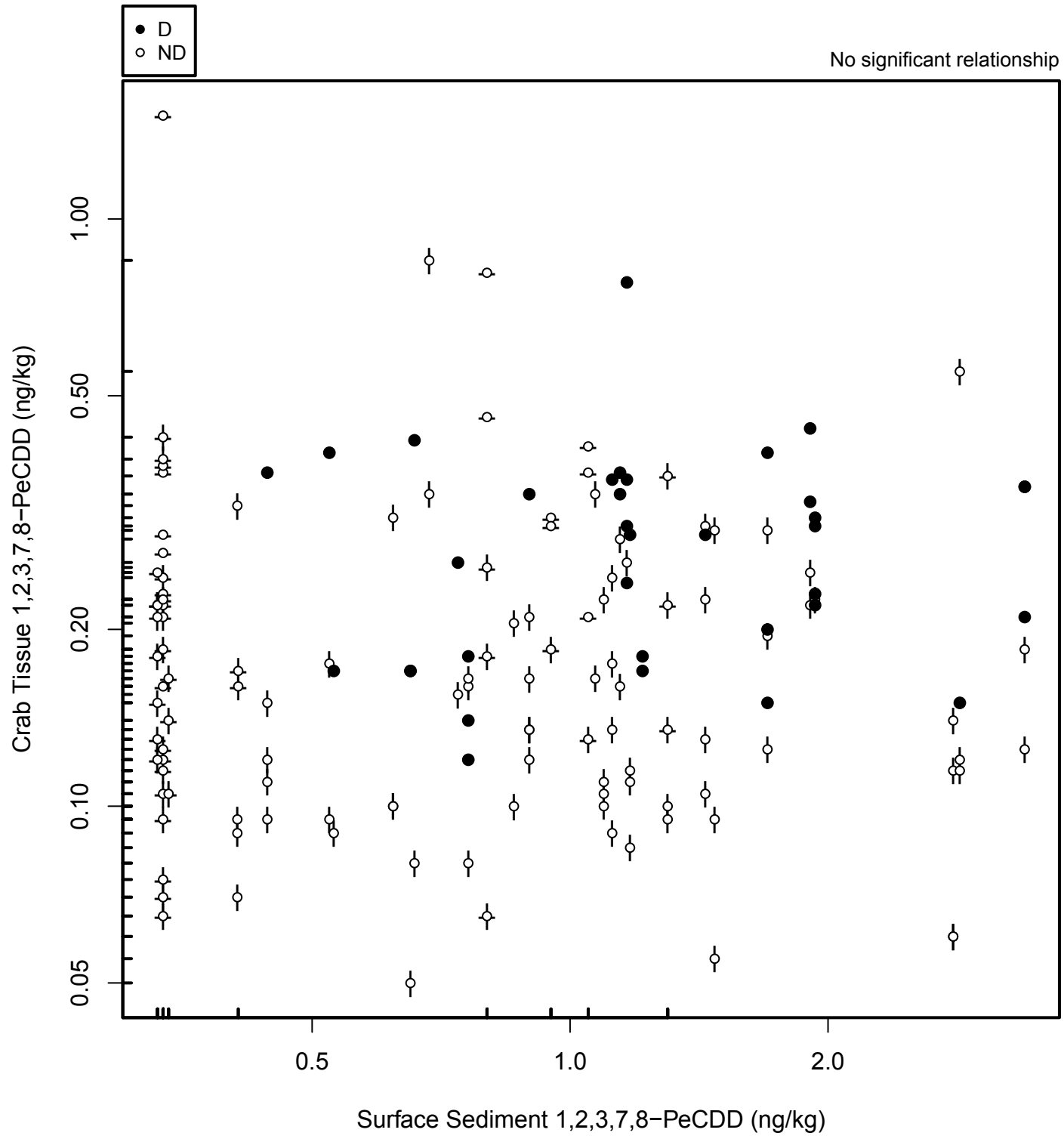
Figure 2
Relationship of D/F Patterns for Selected Collocated Samples of Catfish Tissue, Surface Water, and Surface Sediment
Bioaccumulation Technical Memo
SJRWP Superfund/MIMC and IPC

DRAFT



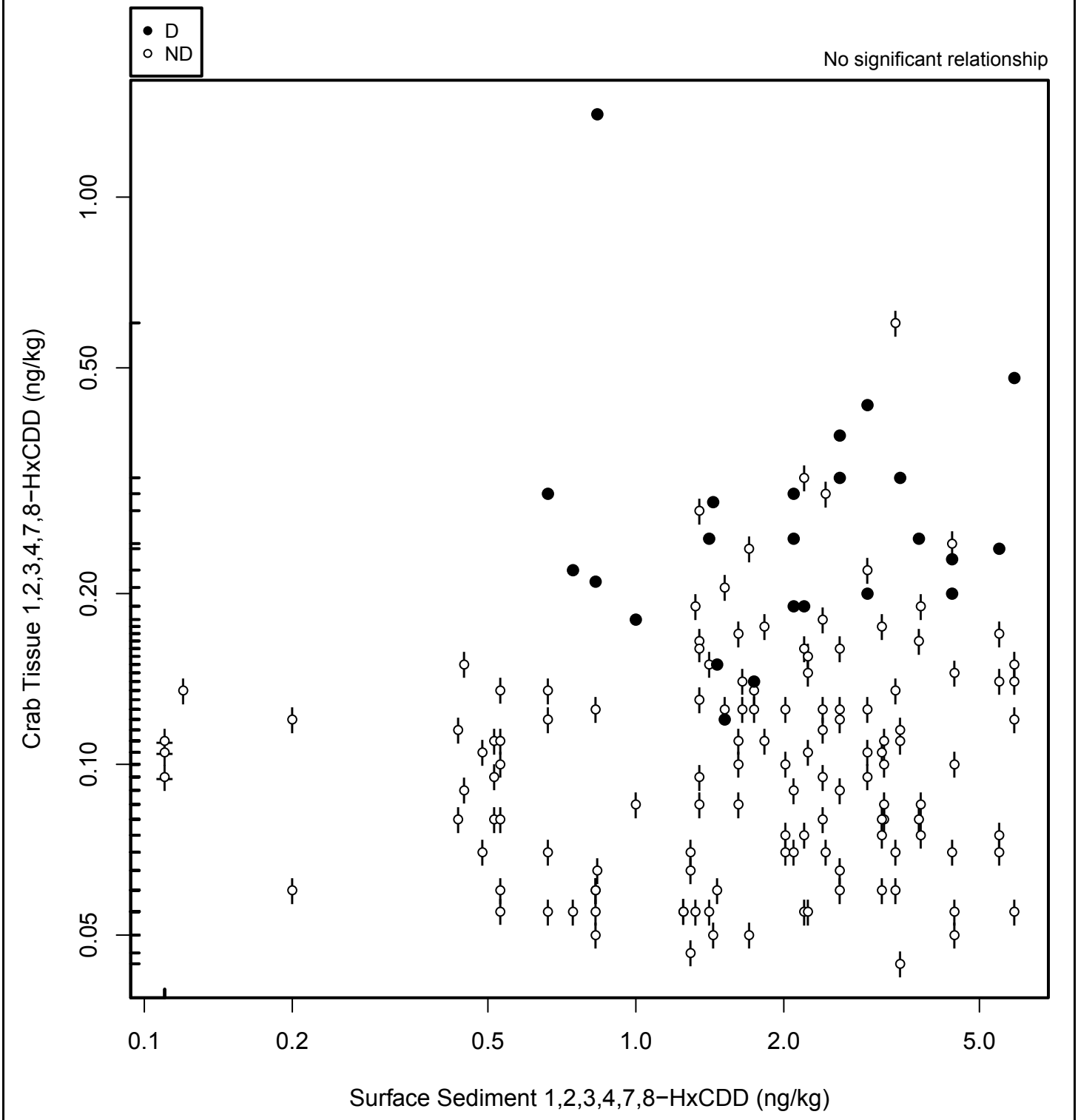
Notes:
D = detected
ND = nondetected; ½ detection limit used
Surface sediment concentrations represent averages of samples within 100 m of each crab sample.
Inward ticks correspond to NDs in the x or y dimensions, as applicable.
Vertical or horizontal symbols represent the axis where data are censored. Censored Kendall's correlation statistic shown at top.

Figure 3
Relationships between Blue Crab Tissue and Surface Sediment Concentrations of 2,3,7,8−TCDD (ng/kg, ND=½DL)
Bioaccumulation Technical Memo
SJRWP Superfund/MIMC and IPC



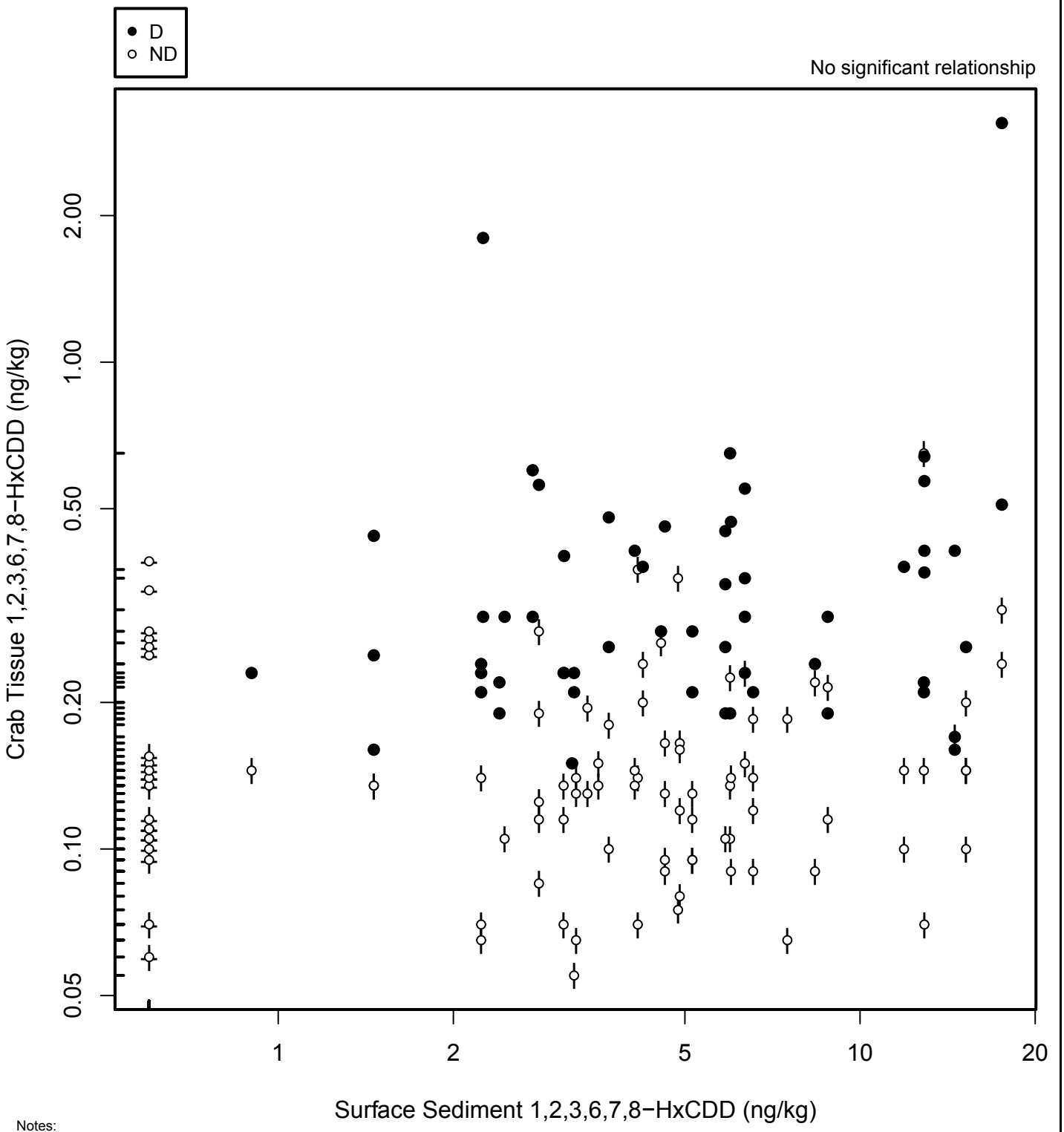
Notes:
D = detected
ND = nondetected; ½ detection limit used
Surface sediment concentrations represent averages of samples within 100 m of each crab sample.
Inward ticks correspond to NDs in the x or y dimensions, as applicable.
Vertical or horizontal symbols represent the axis where data are censored. Censored Kendall's correlation statistic shown at top.

Figure 4
Relationships between Blue Crab Tissue and Surface Sediment Concentrations of 1,2,3,7,8−PeCDD (ng/kg, ND=½DL)
Bioaccumulation Technical Memo
SJRWP Superfund/MIMC and IPC



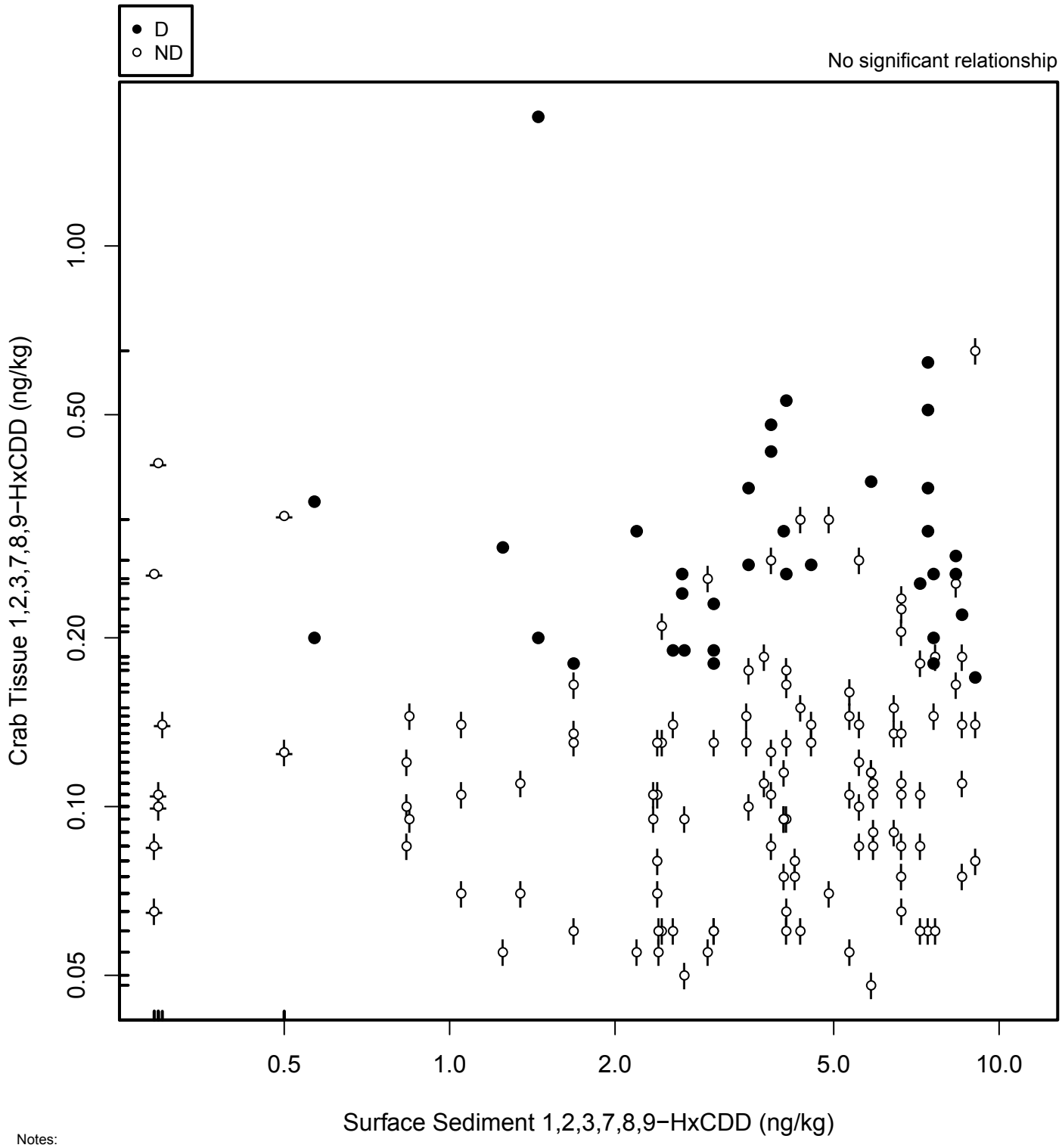
Notes:
D = detected
ND = nondetected; ½ detection limit used
Surface sediment concentrations represent averages of samples within 100 m of each crab sample.
Inward ticks correspond to NDs in the x or y dimensions, as applicable.
Vertical or horizontal symbols represent the axis where data are censored. Censored Kendall's correlation statistic shown at top.

Figure 5
Relationships between Blue Crab Tissue and Surface Sediment Concentrations of 1,2,3,4,7,8−HxCDD (ng/kg, ND=½DL)
Bioaccumulation Technical Memo
SJRWP Superfund/MIMC and IPC



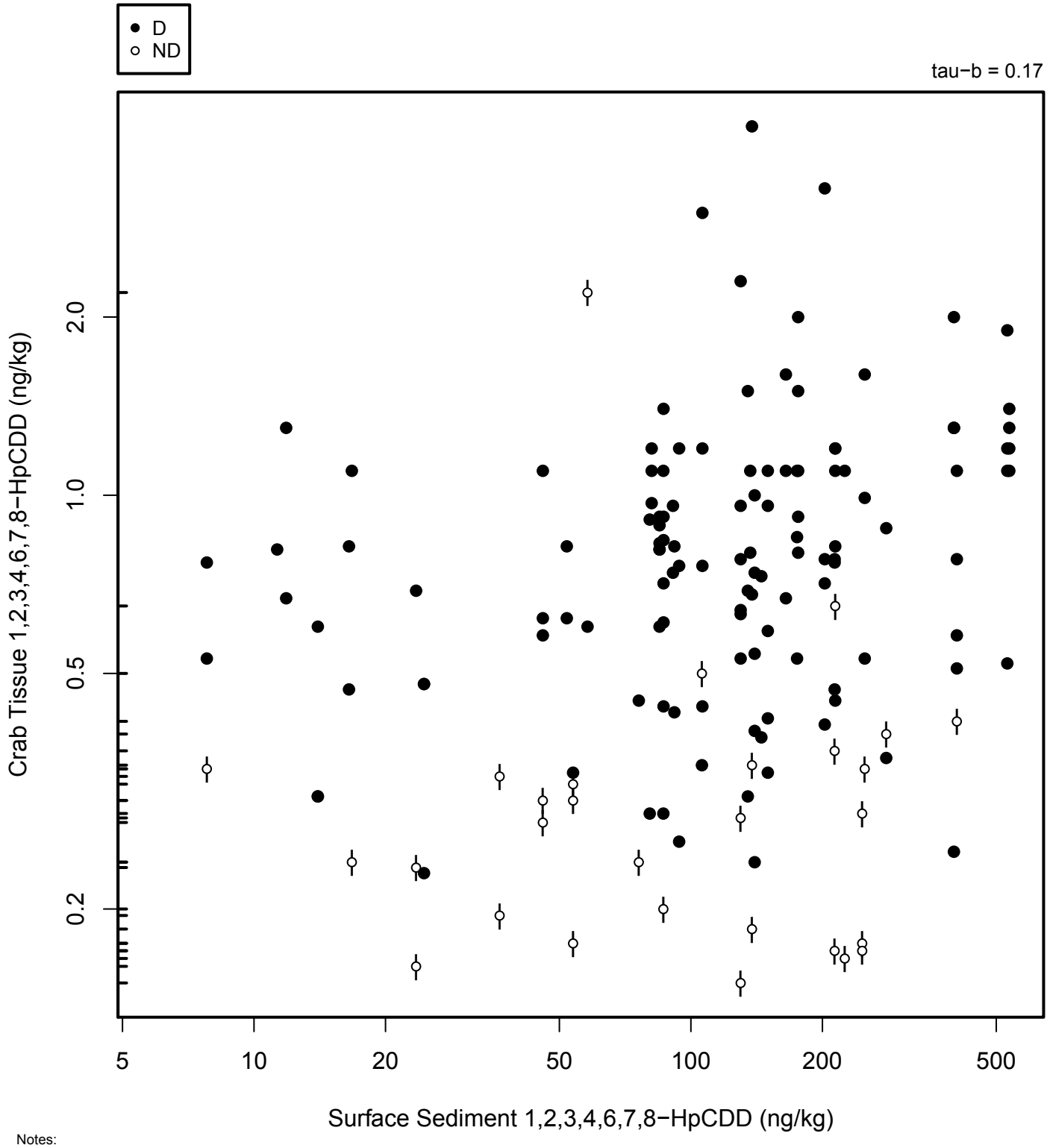
Notes:
D = detected
ND = nondetected; ½ detection limit used
Surface sediment concentrations represent averages of samples within 100 m of each crab sample.
Inward ticks correspond to NDs in the x or y dimensions, as applicable.
Vertical or horizontal symbols represent the axis where data are censored. Censored Kendall's correlation statistic shown at top.

Figure 6
Relationships between Blue Crab Tissue and Surface Sediment Concentrations of 1,2,3,6,7,8−HxCDD (ng/kg, ND=½DL)
Bioaccumulation Technical Memo
SJRWP Superfund/MIMC and IPC



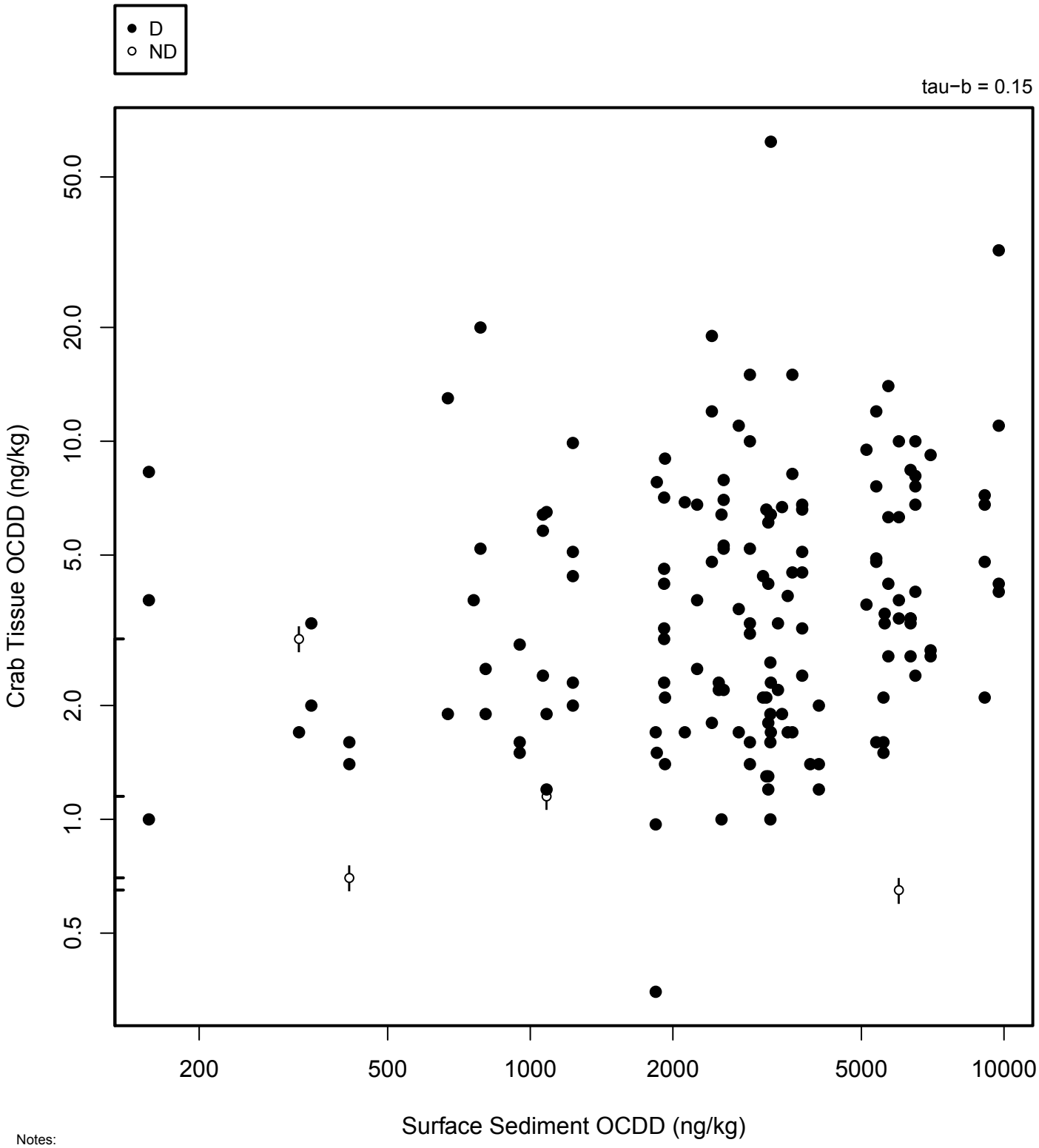
Notes:
D = detected
ND = nondetected; ½ detection limit used
Surface sediment concentrations represent averages of samples within 100 m of each crab sample.
Inward ticks correspond to NDs in the x or y dimensions, as applicable.
Vertical or horizontal symbols represent the axis where data are censored. Censored Kendall's correlation statistic shown at top.

Figure 7
Relationships between Blue Crab Tissue and Surface Sediment Concentrations of 1,2,3,7,8,9−HxCDD (ng/kg, ND=½DL)
Bioaccumulation Technical Memo
SJRWP Superfund/MIMC and IPC



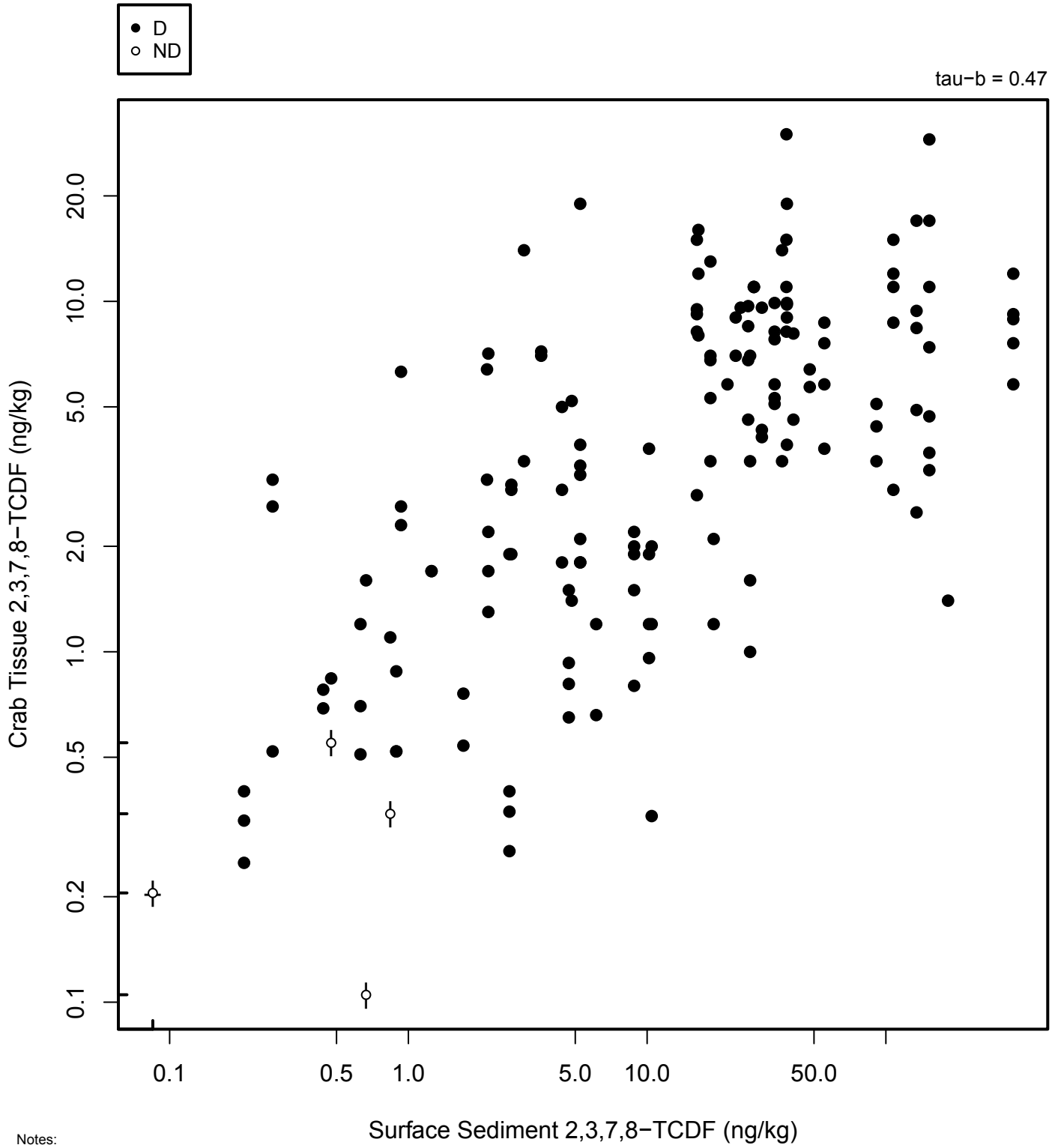
Notes:
D = detected
ND = nondetected; ½ detection limit used
Surface sediment concentrations represent averages of samples within 100 m of each crab sample.
Inward ticks correspond to NDs in the x or y dimensions, as applicable.
Vertical or horizontal symbols represent the axis where data are censored. Censored Kendall's correlation statistic shown at top.

Figure 8
Relationships between Blue Crab Tissue and Surface Sediment Concentrations of 1,2,3,4,6,7,8−HpCDD (ng/kg, ND=½DL)
Bioaccumulation Technical Memo
SJRWP Superfund/MIMC and IPC



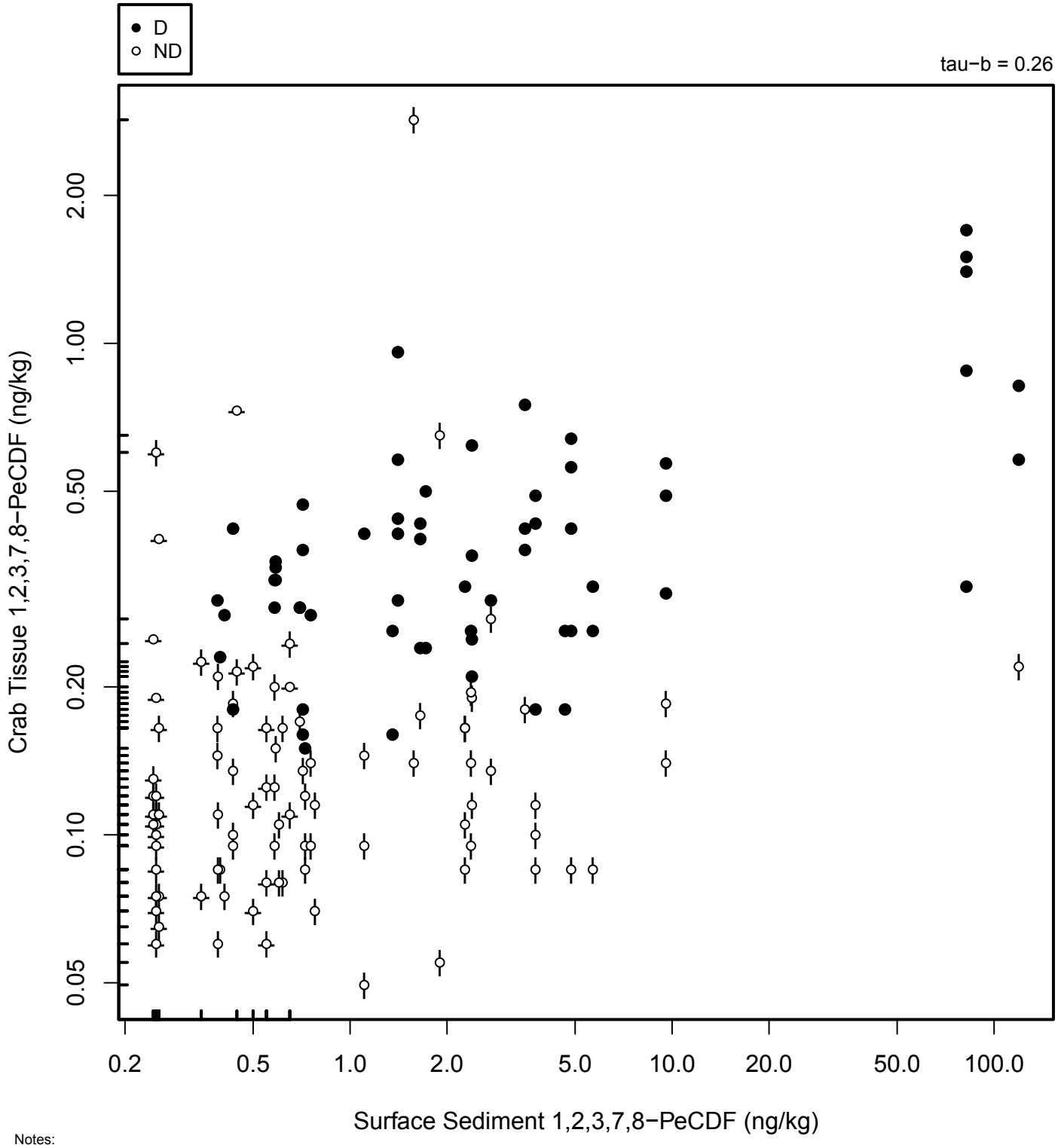
Notes:
D = detected
ND = nondetected; ½ detection limit used
Surface sediment concentrations represent averages of samples within 100 m of each crab sample.
Inward ticks correspond to NDs in the x or y dimensions, as applicable.
Vertical or horizontal symbols represent the axis where data are censored. Censored Kendall's correlation statistic shown at top.

Figure 9
Relationships between Blue Crab Tissue and Surface Sediment Concentrations of OCDD (ng/kg, ND=½DL)
Bioaccumulation Technical Memo
SJRWP Superfund/MIMC and IPC



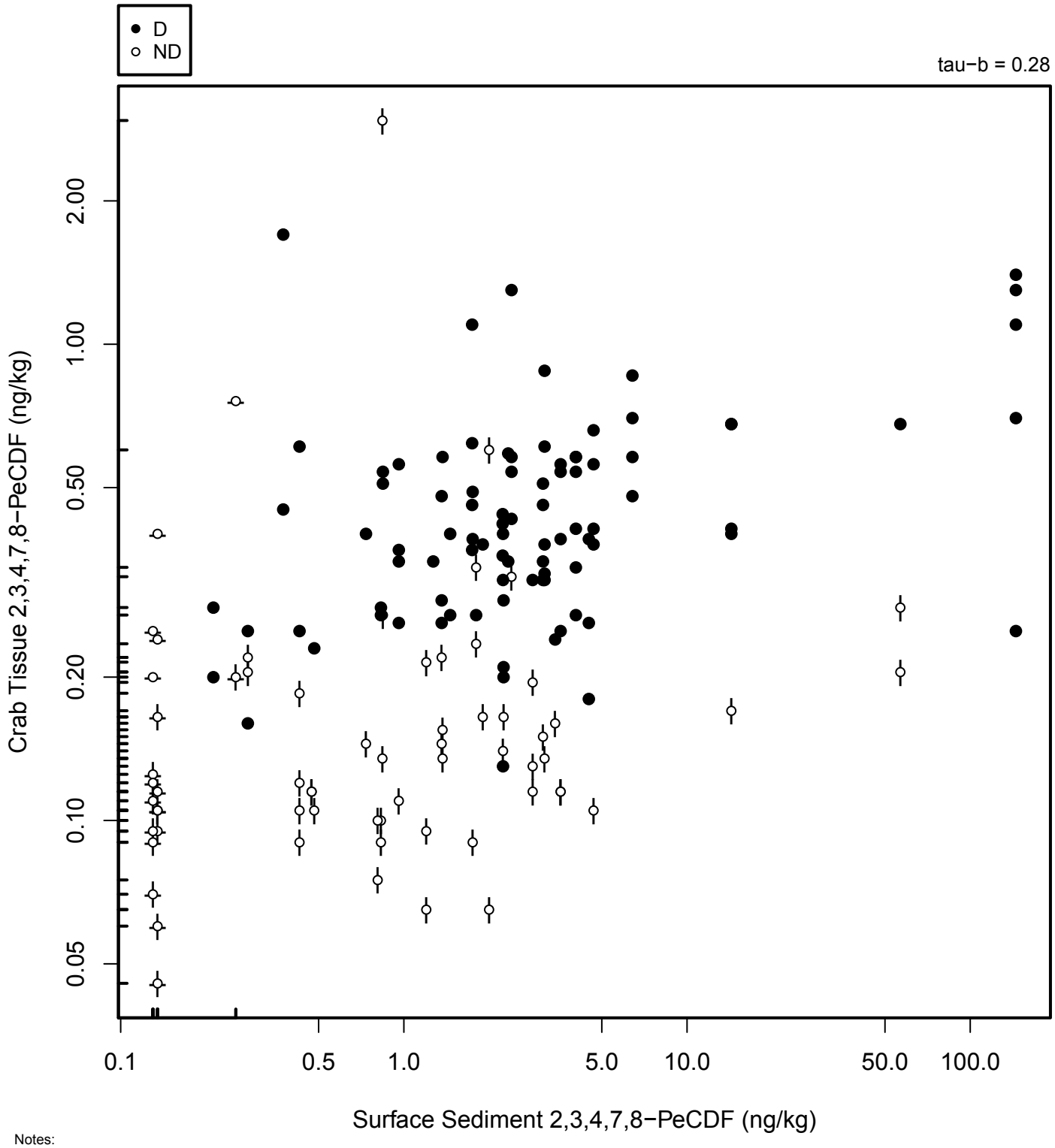
Notes:
D = detected
ND = nondetected; ½ detection limit used
Surface sediment concentrations represent averages of samples within 100 m of each crab sample.
Inward ticks correspond to NDs in the x or y dimensions, as applicable.
Vertical or horizontal symbols represent the axis where data are censored. Censored Kendall's correlation statistic shown at top.

Figure 10
Relationships between Blue Crab Tissue and Surface Sediment Concentrations of 2,3,7,8−TCDF (ng/kg, ND=½DL)
Bioaccumulation Technical Memo
SJRWP Superfund/MIMC and IPC



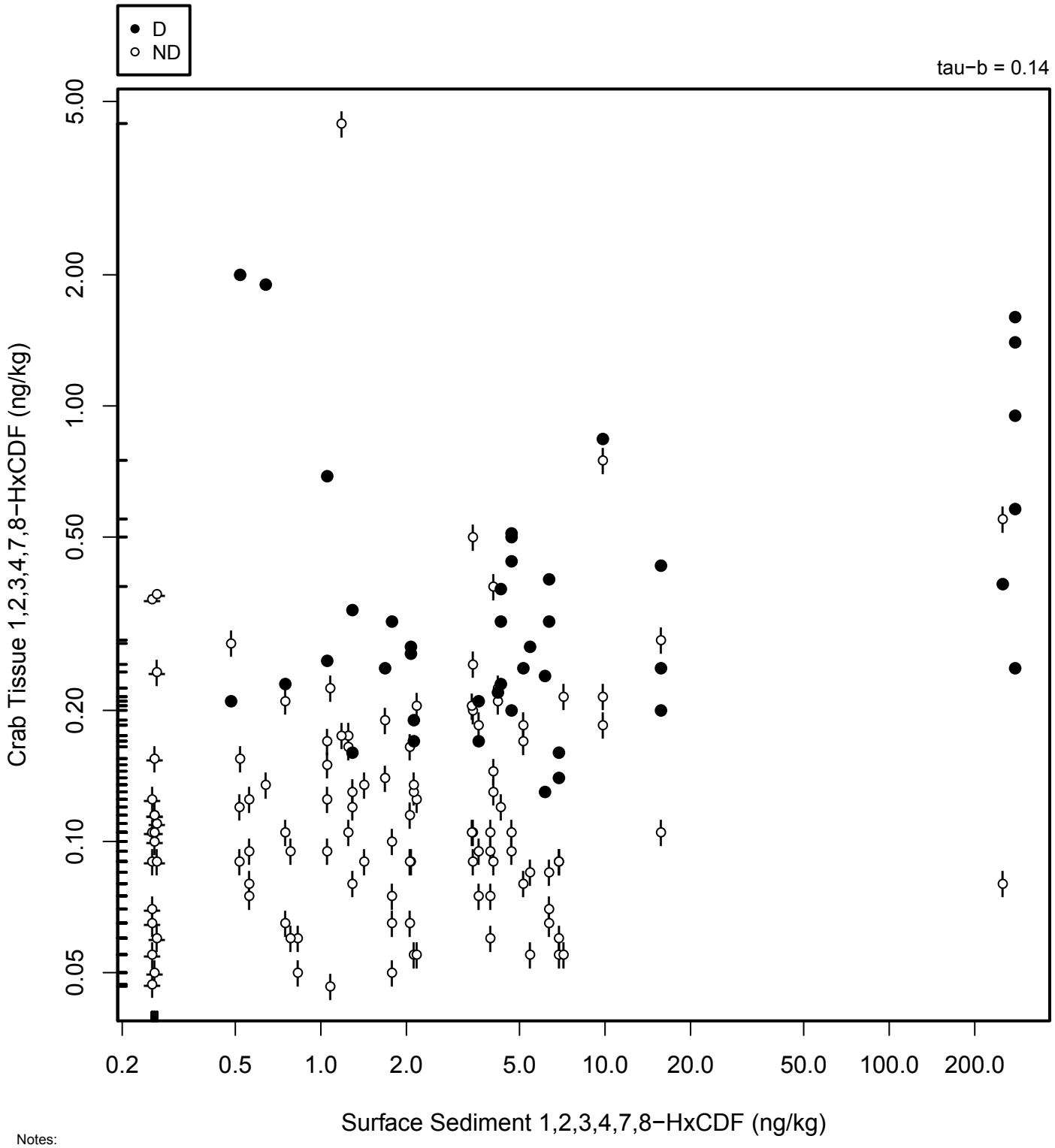
Notes:
D = detected
ND = nondetected; ½ detection limit used
Surface sediment concentrations represent averages of samples within 100 m of each crab sample.
Inward ticks correspond to NDs in the x or y dimensions, as applicable.
Vertical or horizontal symbols represent the axis where data are censored. Censored Kendall's correlation statistic shown at top.

Figure 11
Relationships between Blue Crab Tissue and Surface Sediment Concentrations of 1,2,3,7,8−PeCDF (ng/kg, ND=½DL)
Bioaccumulation Technical Memo
SJRWP Superfund/MIMC and IPC



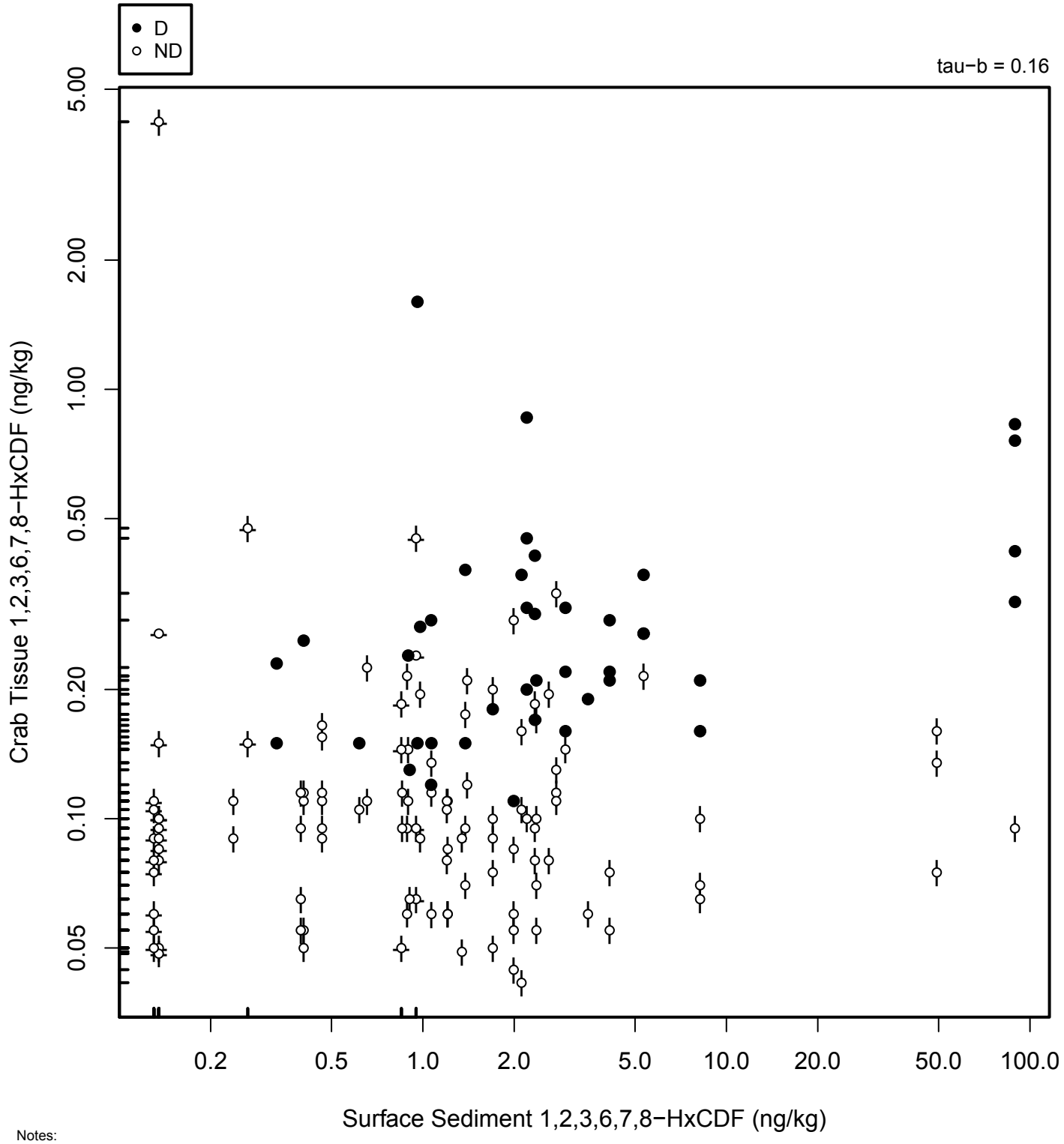
Notes:
D = detected
ND = nondetected; ½ detection limit used
Surface sediment concentrations represent averages of samples within 100 m of each crab sample.
Inward ticks correspond to NDs in the x or y dimensions, as applicable.
Vertical or horizontal symbols represent the axis where data are censored. Censored Kendall's correlation statistic shown at top.

Figure 12
Relationships between Blue Crab Tissue and Surface Sediment Concentrations of 2,3,4,7,8−PeCDF (ng/kg, ND=½DL)
Bioaccumulation Technical Memo
SJRWP Superfund/MIMC and IPC



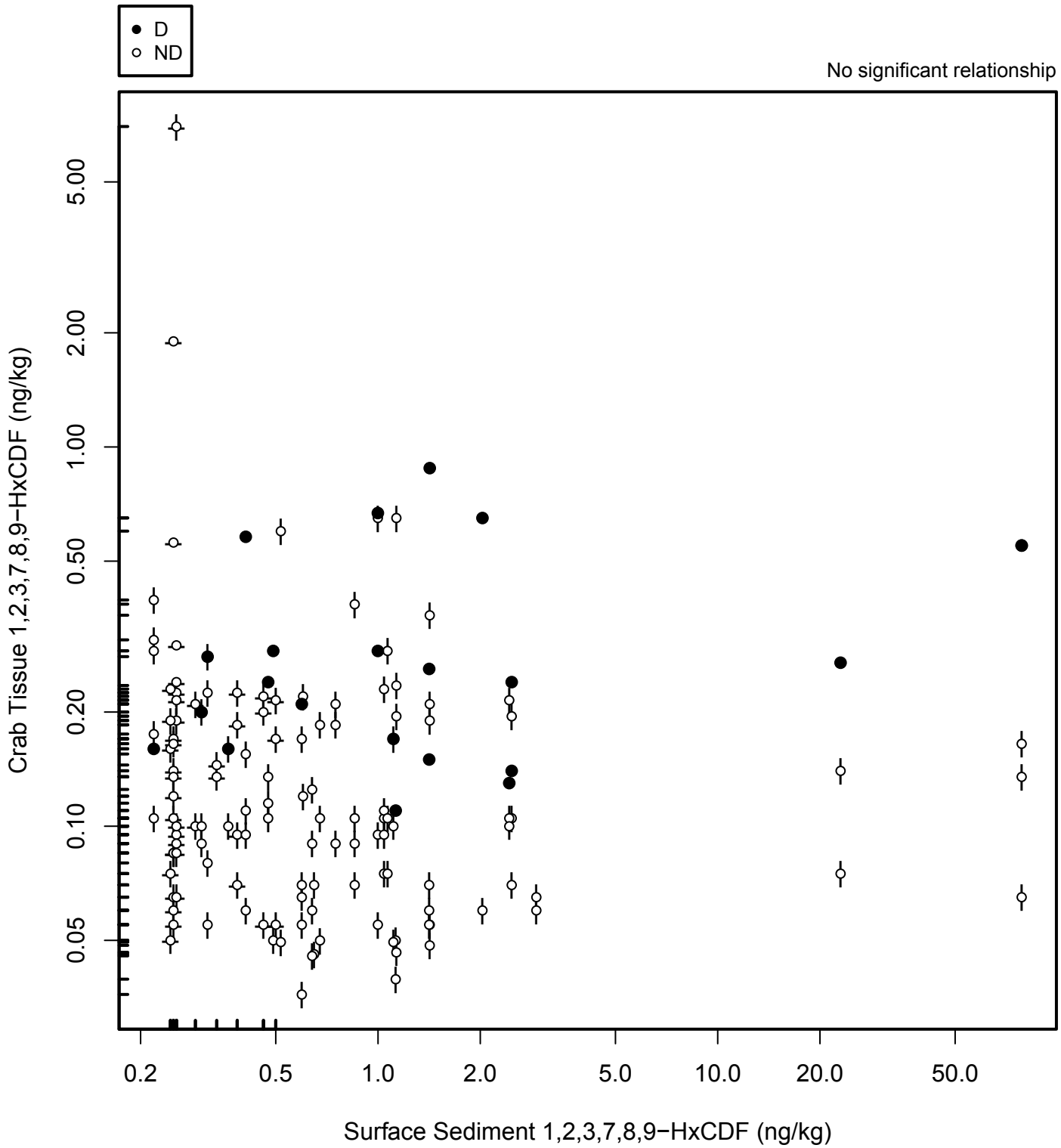
Notes:
D = detected
ND = nondetected; ½ detection limit used
Surface sediment concentrations represent averages of samples within 100 m of each crab sample.
Inward ticks correspond to NDs in the x or y dimensions, as applicable.
Vertical or horizontal symbols represent the axis where data are censored. Censored Kendall's correlation statistic shown at top.

Figure 13
Relationships between Blue Crab Tissue and Surface Sediment Concentrations of 1,2,3,4,7,8−HxCDF (ng/kg, ND=½DL)
Bioaccumulation Technical Memo
SJRWP Superfund/MIMC and IPC



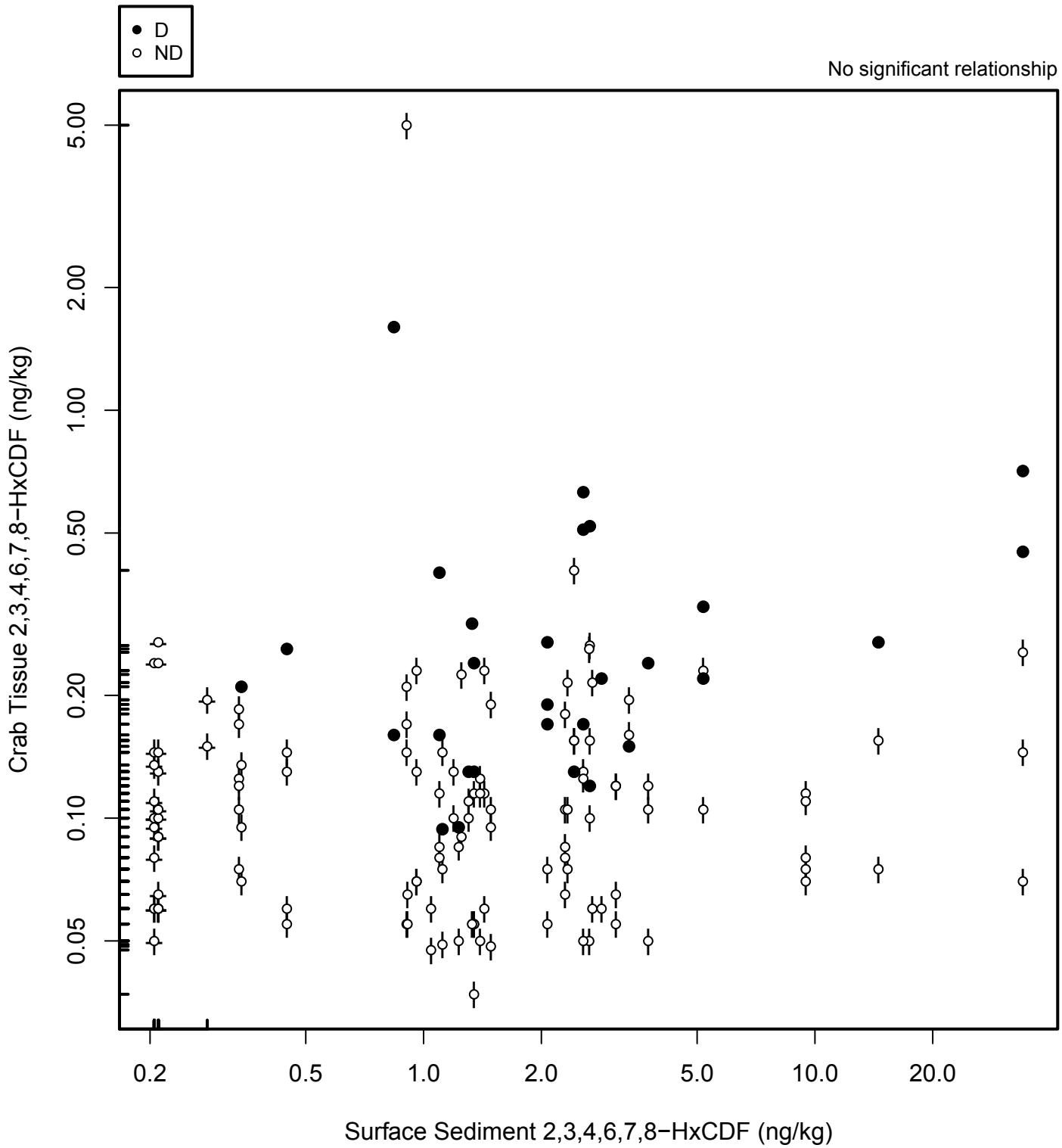
Notes:
D = detected
ND = nondetected; ½ detection limit used
Surface sediment concentrations represent averages of samples within 100 m of each crab sample.
Inward ticks correspond to NDs in the x or y dimensions, as applicable.
Vertical or horizontal symbols represent the axis where data are censored. Censored Kendall's correlation statistic shown at top.

Figure 14
Relationships between Blue Crab Tissue and Surface Sediment Concentrations of 1,2,3,6,7,8−HxCDF (ng/kg, ND=½DL)
Bioaccumulation Technical Memo
SJRWP Superfund/MIMC and IPC



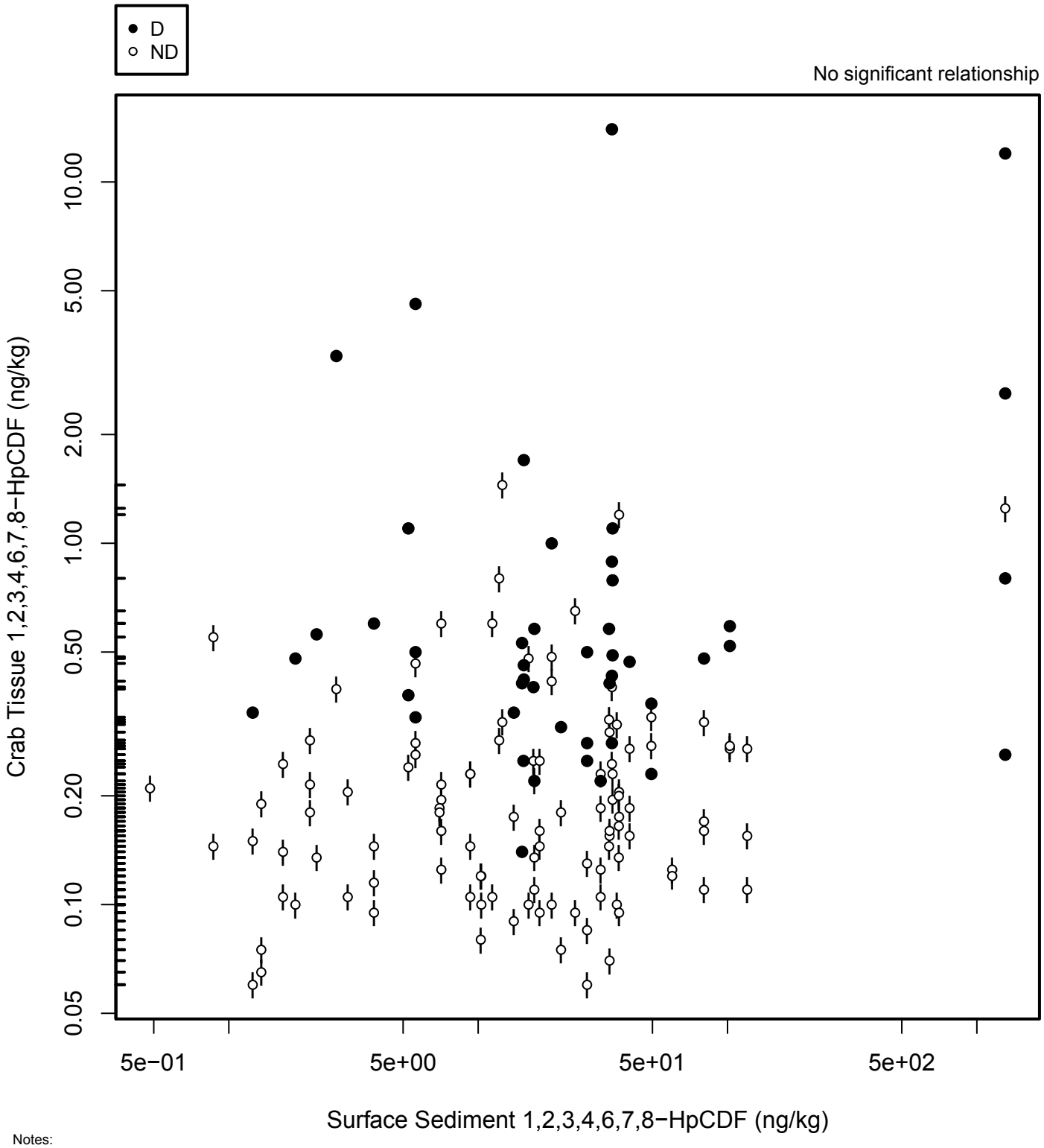
Notes:
D = detected
ND = nondetected; ½ detection limit used
Surface sediment concentrations represent averages of samples within 100 m of each crab sample.
Inward ticks correspond to NDs in the x or y dimensions, as applicable.
Vertical or horizontal symbols represent the axis where data are censored. Censored Kendall's correlation statistic shown at top.

Figure 15
Relationships between Blue Crab Tissue and Surface Sediment Concentrations of1,2,3,7,8,9−HxCDF (ng/kg, ND=½DL)
Bioaccumulation Technical Memo
SJRWP Superfund/MIMC and IPC



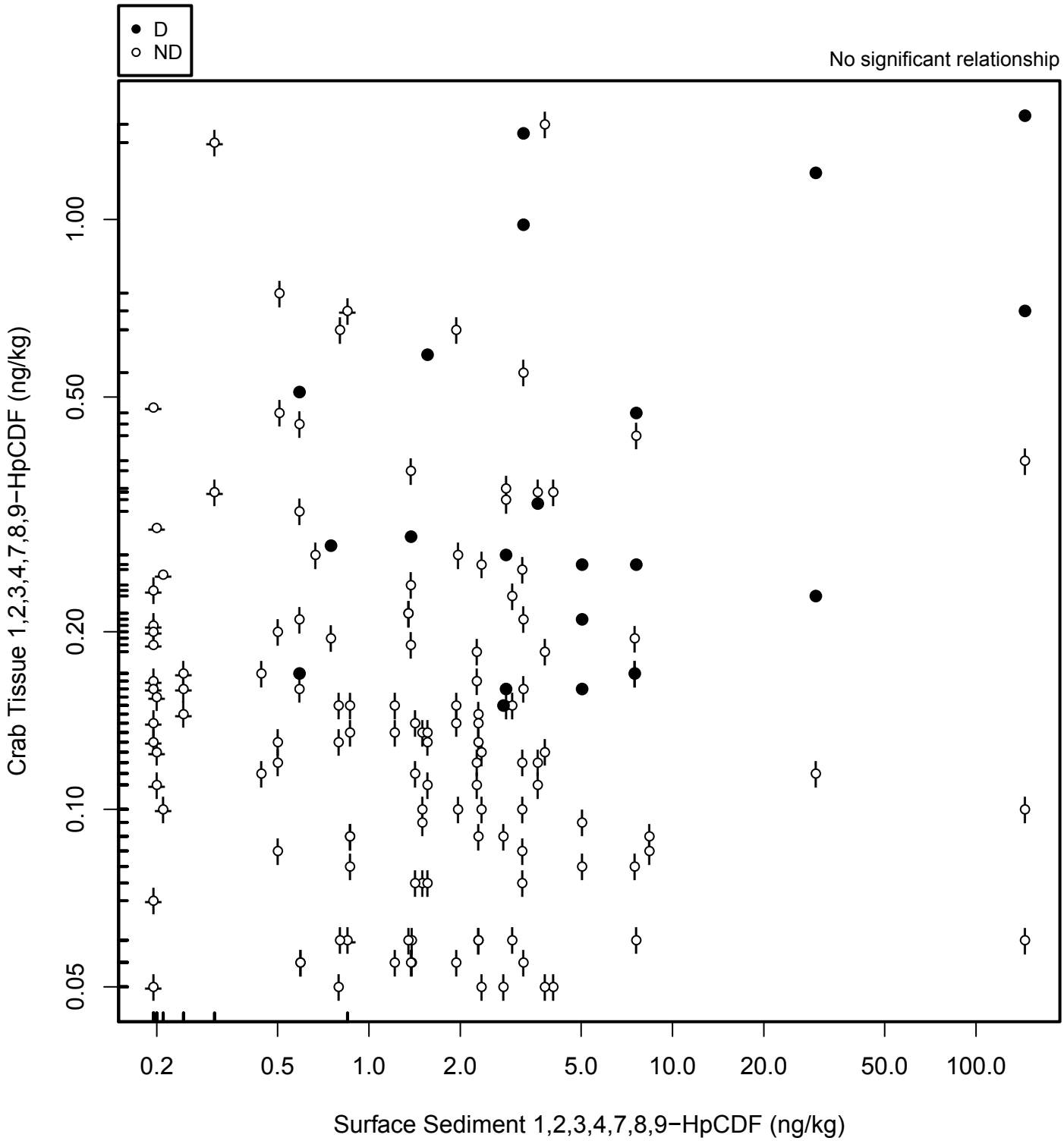
Notes:
D = detected
ND = nondetected; ½ detection limit used
Surface sediment concentrations represent averages of samples within 100 m of each crab sample.
Inward ticks correspond to NDs in the x or y dimensions, as applicable.
Vertical or horizontal symbols represent the axis where data are censored. Censored Kendall's correlation statistic shown at top.

Figure 16
Relationships between Blue Crab Tissue and Surface Sediment Concentrations of 2,3,4,6,7,8−HxCDF (ng/kg, ND=½DL)
Bioaccumulation Technical Memo
SJRWP Superfund/MIMC and IPC



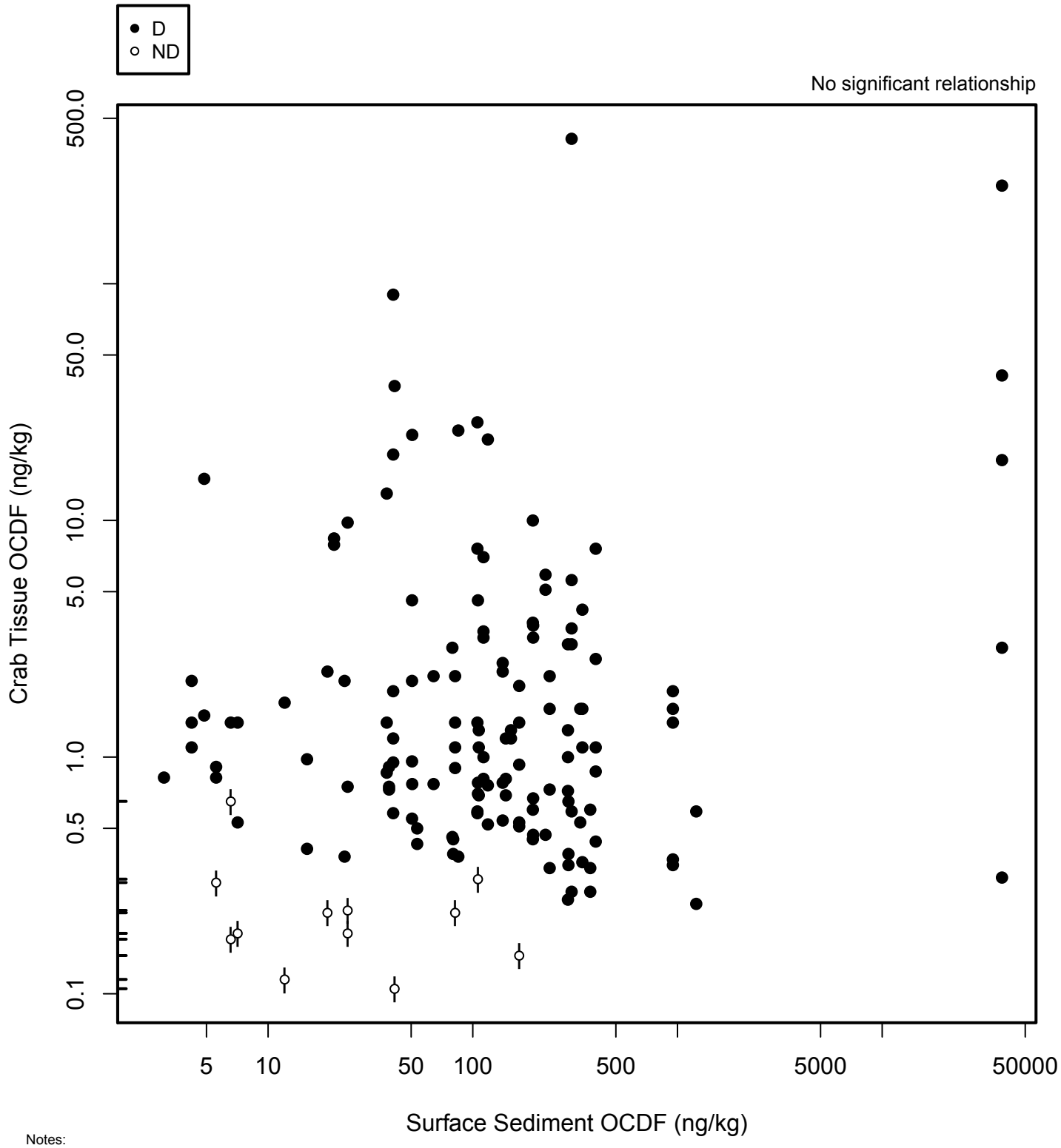
Notes:
D = detected
ND = nondetected; ½ detection limit used
Surface sediment concentrations represent averages of samples within 100 m of each crab sample.
Inward ticks correspond to NDs in the x or y dimensions, as applicable.
Vertical or horizontal symbols represent the axis where data are censored. Censored Kendall's correlation statistic shown at top.

Figure 17
Relationships between Blue Crab Tissue and Surface Sediment Concentrations of 1,2,3,4,6,7,8−HpCDF (ng/kg, ND=½DL)
Bioaccumulation Technical Memo
SJRWP Superfund/MIMC and IPC



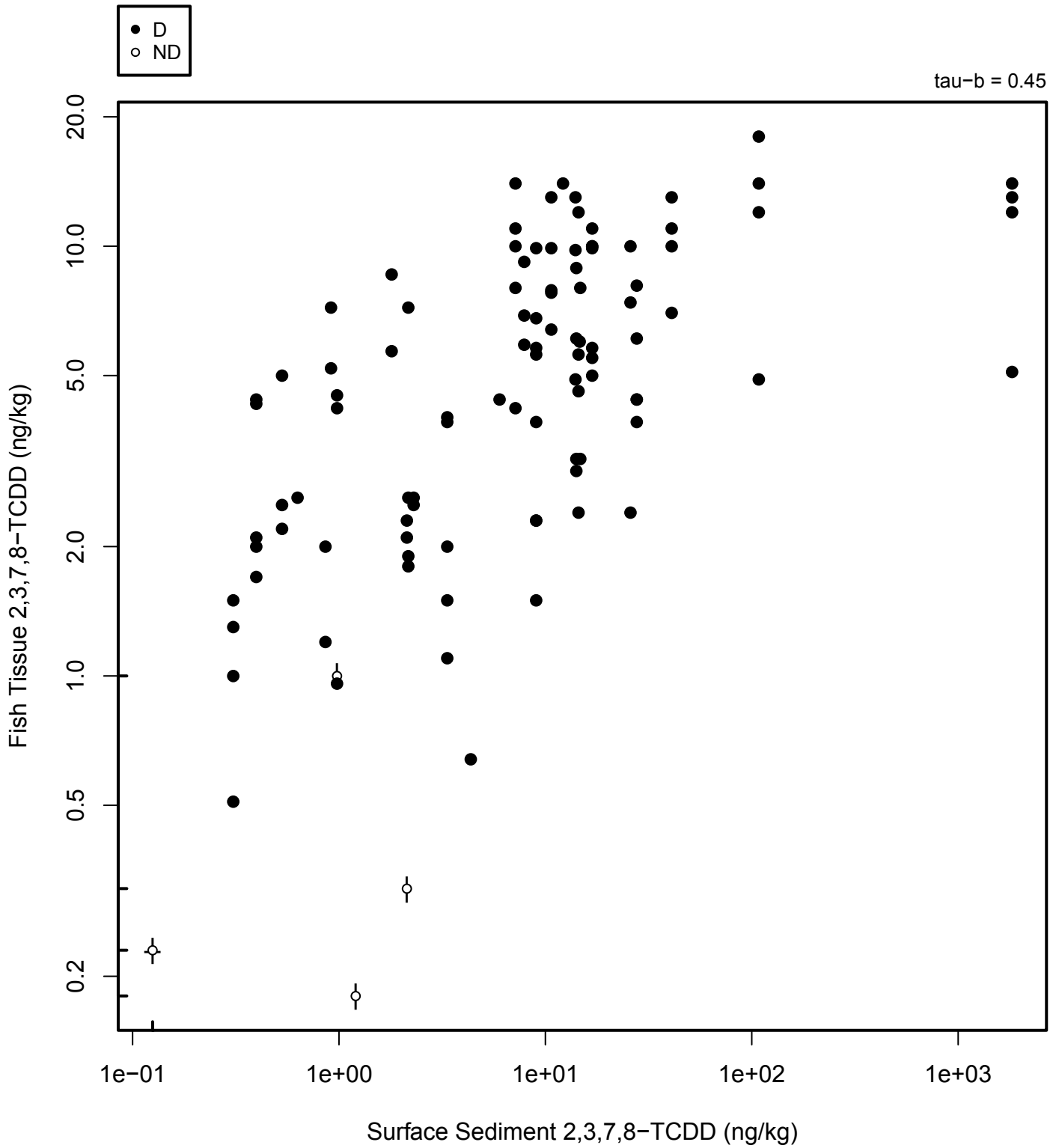
Notes:
D = detected
ND = nondetected; ½ detection limit used
Surface sediment concentrations represent averages of samples within 100 m of each crab sample.
Inward ticks correspond to NDs in the x or y dimensions, as applicable.
Vertical or horizontal symbols represent the axis where data are censored. Censored Kendall's correlation statistic shown at top.

Figure 18
Relationships between Blue Crab Tissue and Surface Sediment Concentrations of 1,2,3,4,7,8,9−HpCDF (ng/kg, ND=½DL)
Bioaccumulation Technical Memo
SJRWP Superfund/MIMC and IPC



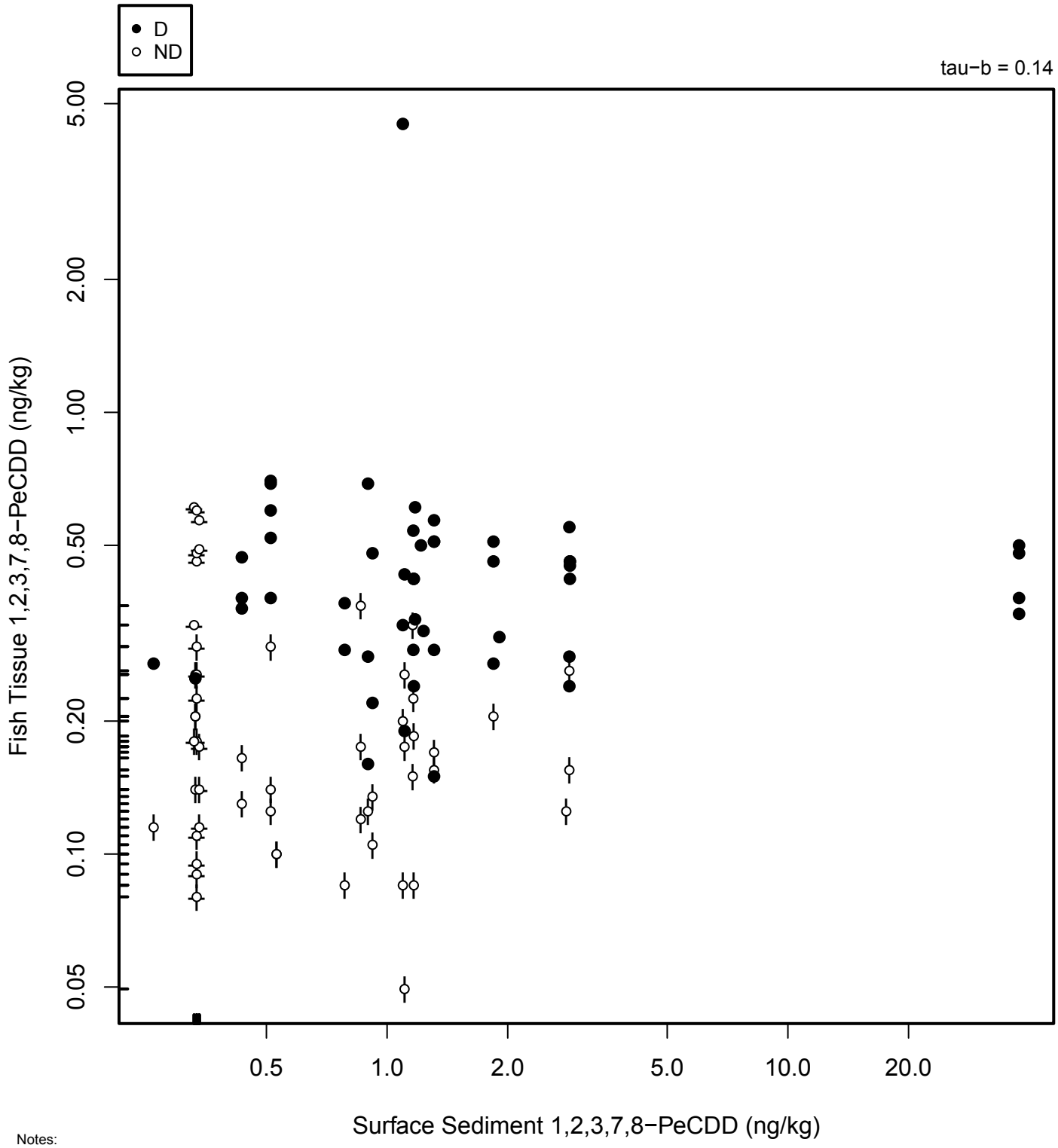
Notes:
D = detected
ND = nondetected; ½ detection limit used
Surface sediment concentrations represent averages of samples within 100 m of each crab sample.
Inward ticks correspond to NDs in the x or y dimensions, as applicable.
Vertical or horizontal symbols represent the axis where data are censored. Censored Kendall's correlation statistic shown at top.

Figure 19
Relationships between Blue Crab Tissue and Surface Sediment Concentrations of OCDF (ng/kg, ND=½DL)
Bioaccumulation Technical Memo
SJRWP Superfund/MIMC and IPC



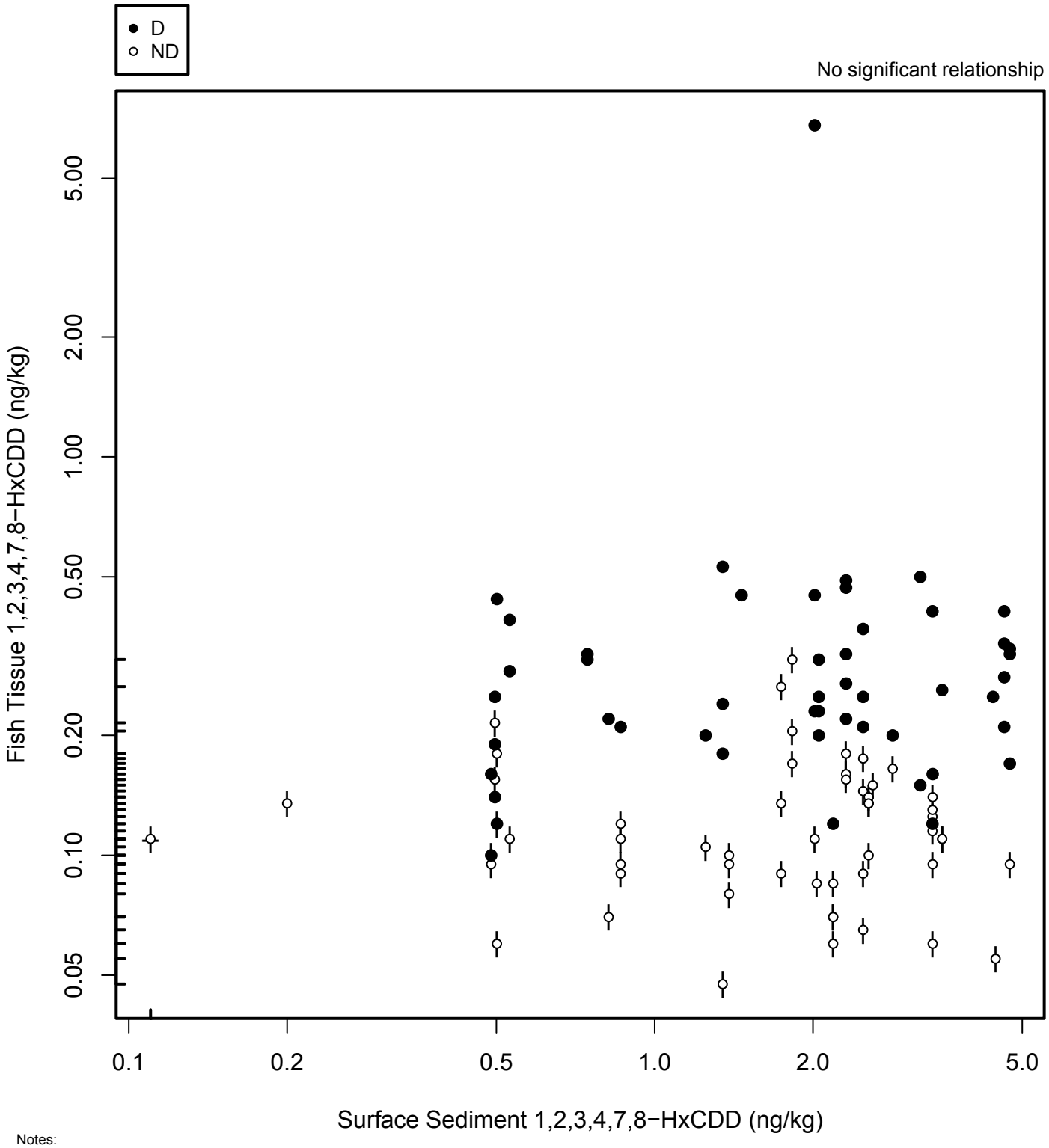
Notes:
D = detected
ND = nondetected; ½ detection limit used
Surface sediment concentrations represent averages of samples within 1000 m of each fish sample.
Inward ticks correspond to NDs in the x or y dimensions, as applicable.
Vertical or horizontal symbols represent the axis where data are censored. Censored Kendall's correlation statistic shown at top.

Figure 20
Relationships between Catfish Tissue and Surface Sediment Concentrations of 2,3,7,8−TCDD (ng/kg, ND=½DL)
Bioaccumulation Technical Memo
SJRWP Superfund/MIMC and IPC



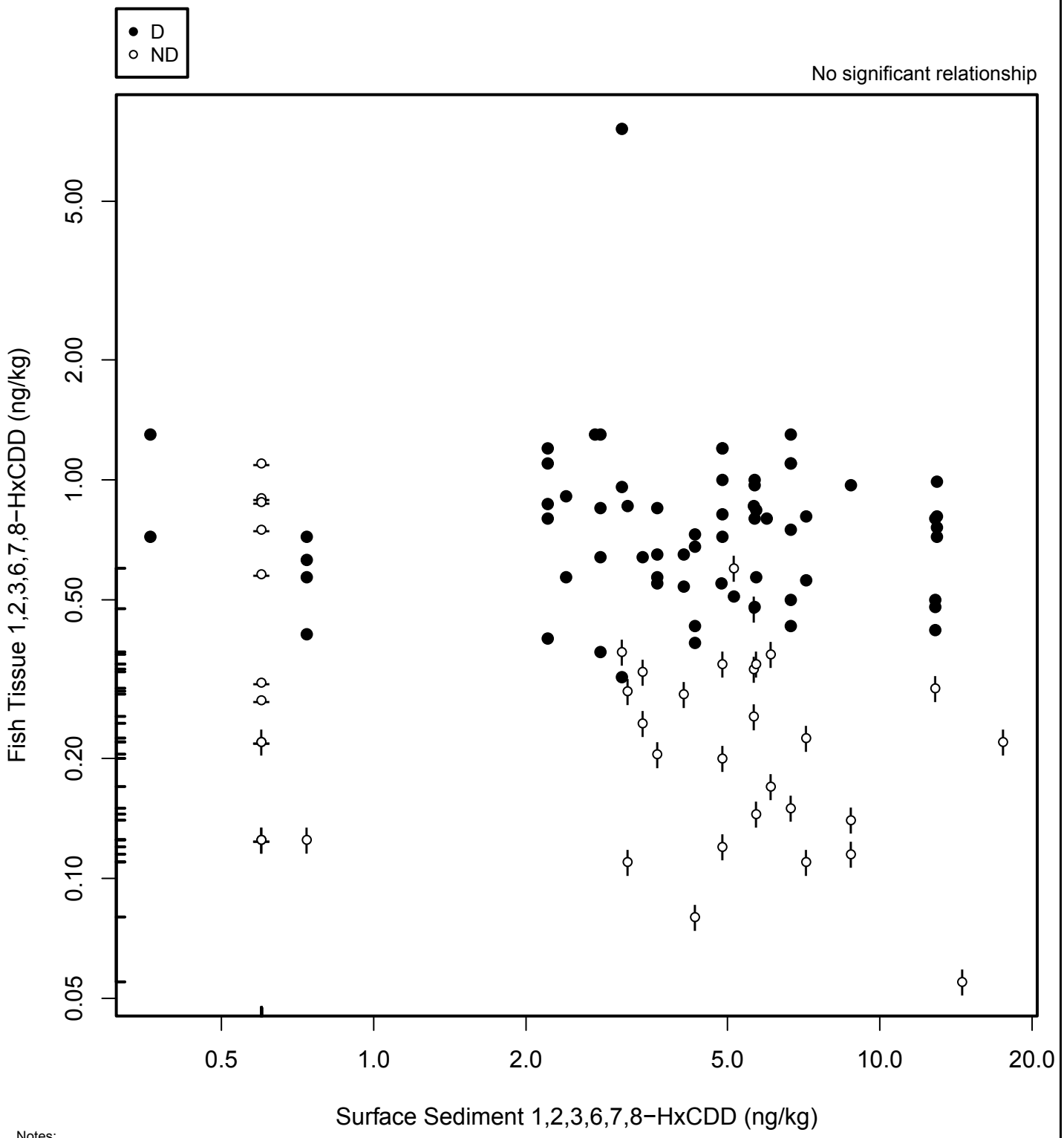
Notes:
D = detected
ND = nondetected; ½ detection limit used
Surface sediment concentrations represent averages of samples within 1000 m of each fish sample.
Inward ticks correspond to NDs in the x or y dimensions, as applicable.
Vertical or horizontal symbols represent the axis where data are censored. Censored Kendall's correlation statistic shown at top.

Figure 21
Relationships between Catfish Tissue and Surface Sediment Concentrations of 1,2,3,7,8−PeCDD (ng/kg, ND=½DL)
Bioaccumulation Technical Memo
SJRWP Superfund/MIMC and IPC



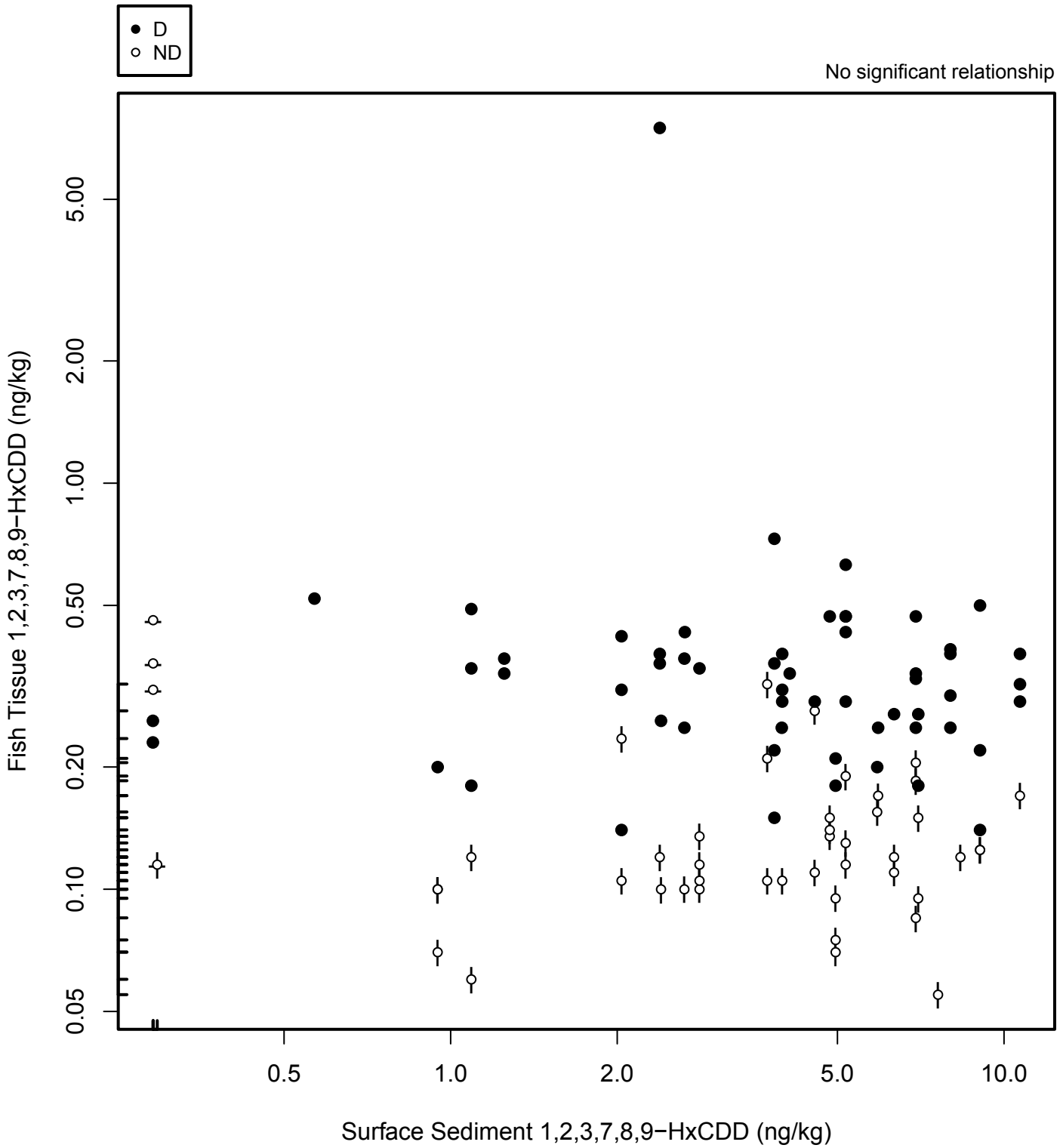
Notes:
D = detected
ND = nondetected; ½ detection limit used
Surface sediment concentrations represent averages of samples within 1000 m of each fish sample.
Inward ticks correspond to NDs in the x or y dimensions, as applicable.
Vertical or horizontal symbols represent the axis where data are censored. Censored Kendall's correlation statistic shown at top.

Figure 22
Relationships between Catfish Tissue and Surface Sediment Concentrations of 1,2,3,4,7,8−HxCDD (ng/kg, ND=½DL)
Bioaccumulation Technical Memo
SJRWP Superfund/MIMC and IPC



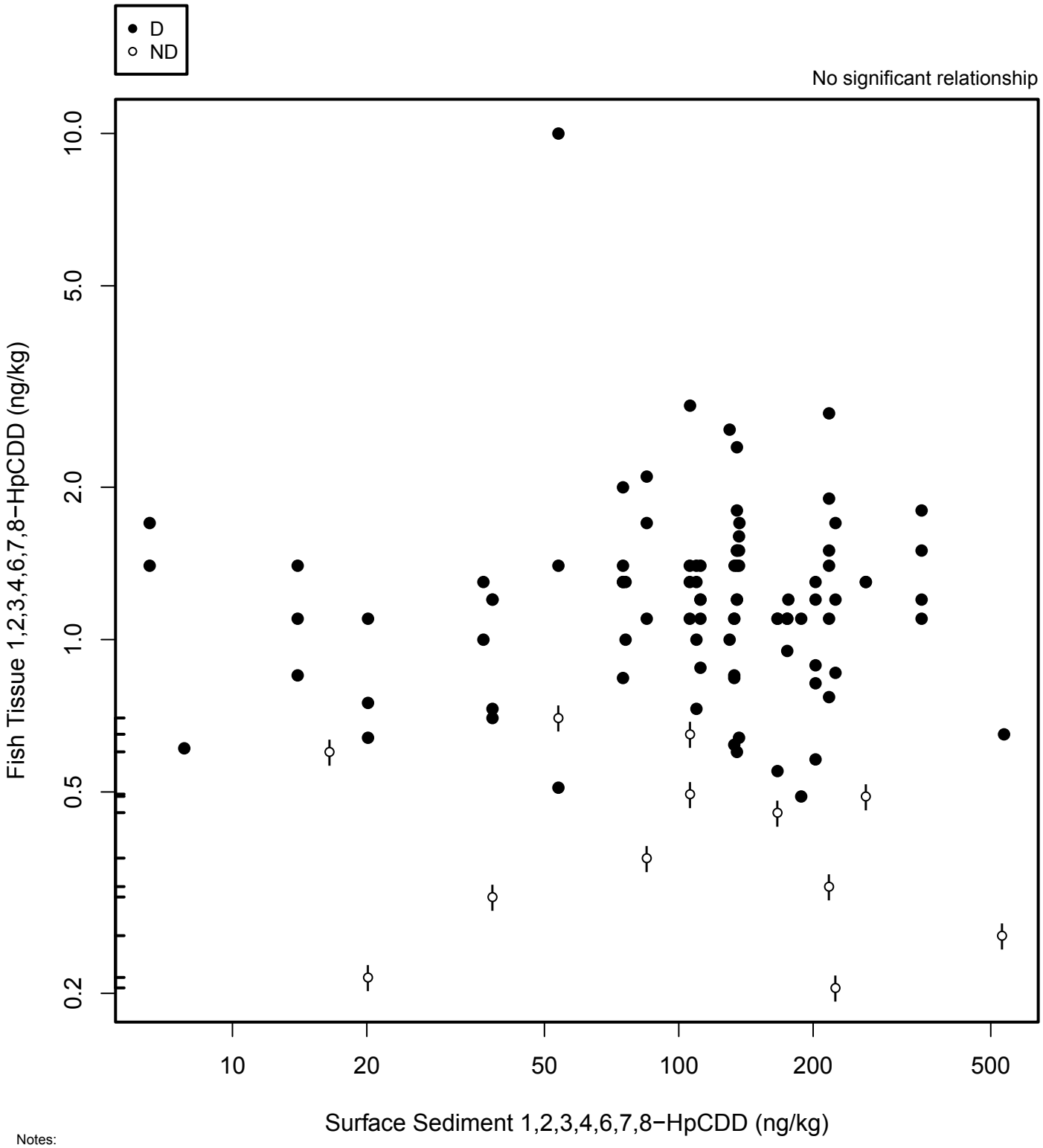
Notes:
D = detected
ND = nondetected; ½ detection limit used
Surface sediment concentrations represent averages of samples within 1000 m of each fish sample.
Inward ticks correspond to NDs in the x or y dimensions, as applicable.
Vertical or horizontal symbols represent the axis where data are censored. Censored Kendall's correlation statistic shown at top.

Figure 23
Relationships between Catfish Tissue and Surface Sediment Concentrations of 1,2,3,6,7,8−HxCDD (ng/kg, ND=½DL)
Bioaccumulation Technical Memo
SJRWP Superfund/MIMC and IPC



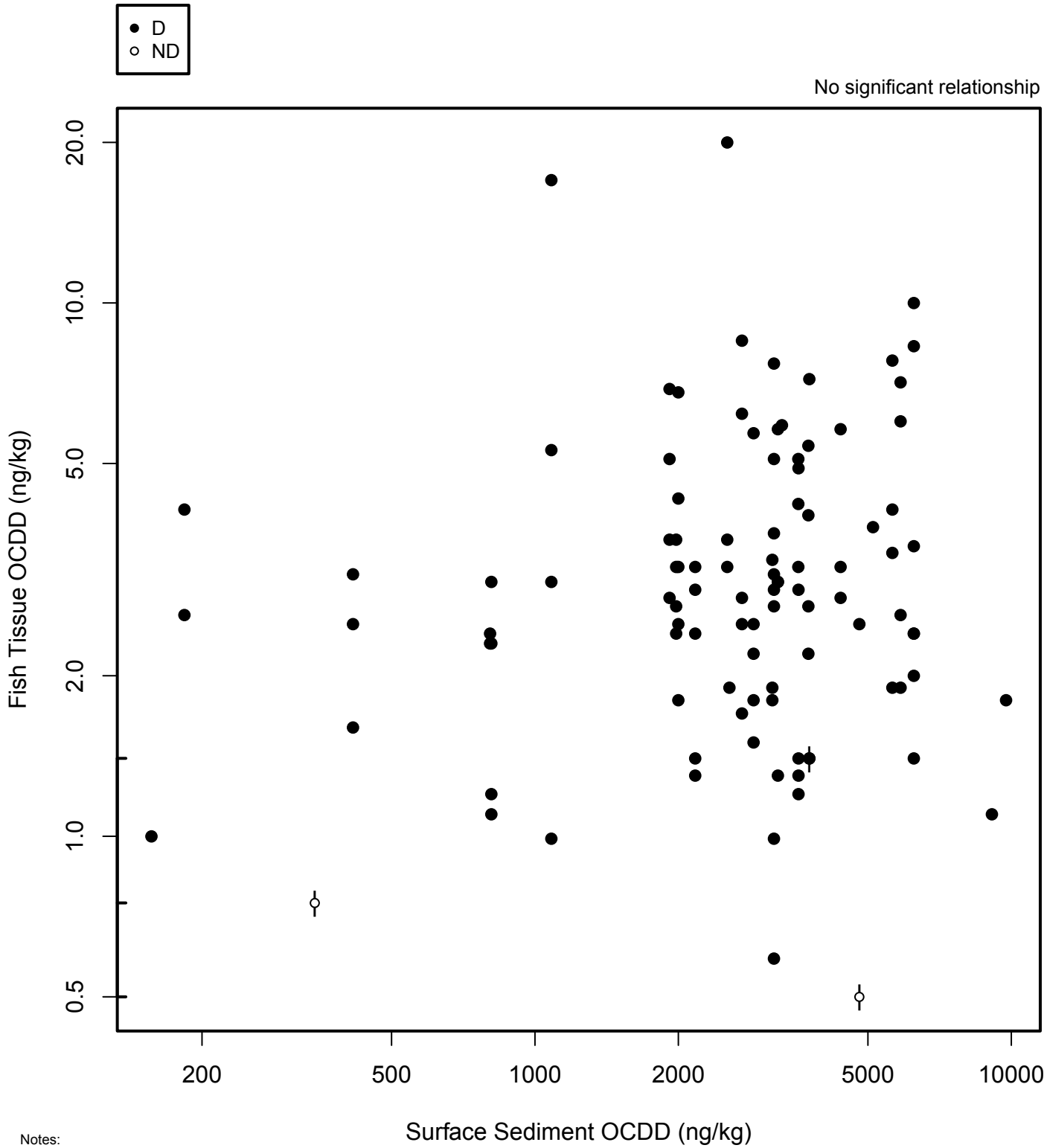
Notes:
D = detected
ND = nondetected; ½ detection limit used
Surface sediment concentrations represent averages of samples within 1000 m of each fish sample.
Inward ticks correspond to NDs in the x or y dimensions, as applicable.
Vertical or horizontal symbols represent the axis where data are censored. Censored Kendall's correlation statistic shown at top.

Figure 24
Relationships between Catfish Tissue and Surface Sediment Concentrations of 1,2,3,7,8,9−HxCDD (ng/kg, ND=½DL)
Bioaccumulation Technical Memo
SJRWP Superfund/MIMC and IPC



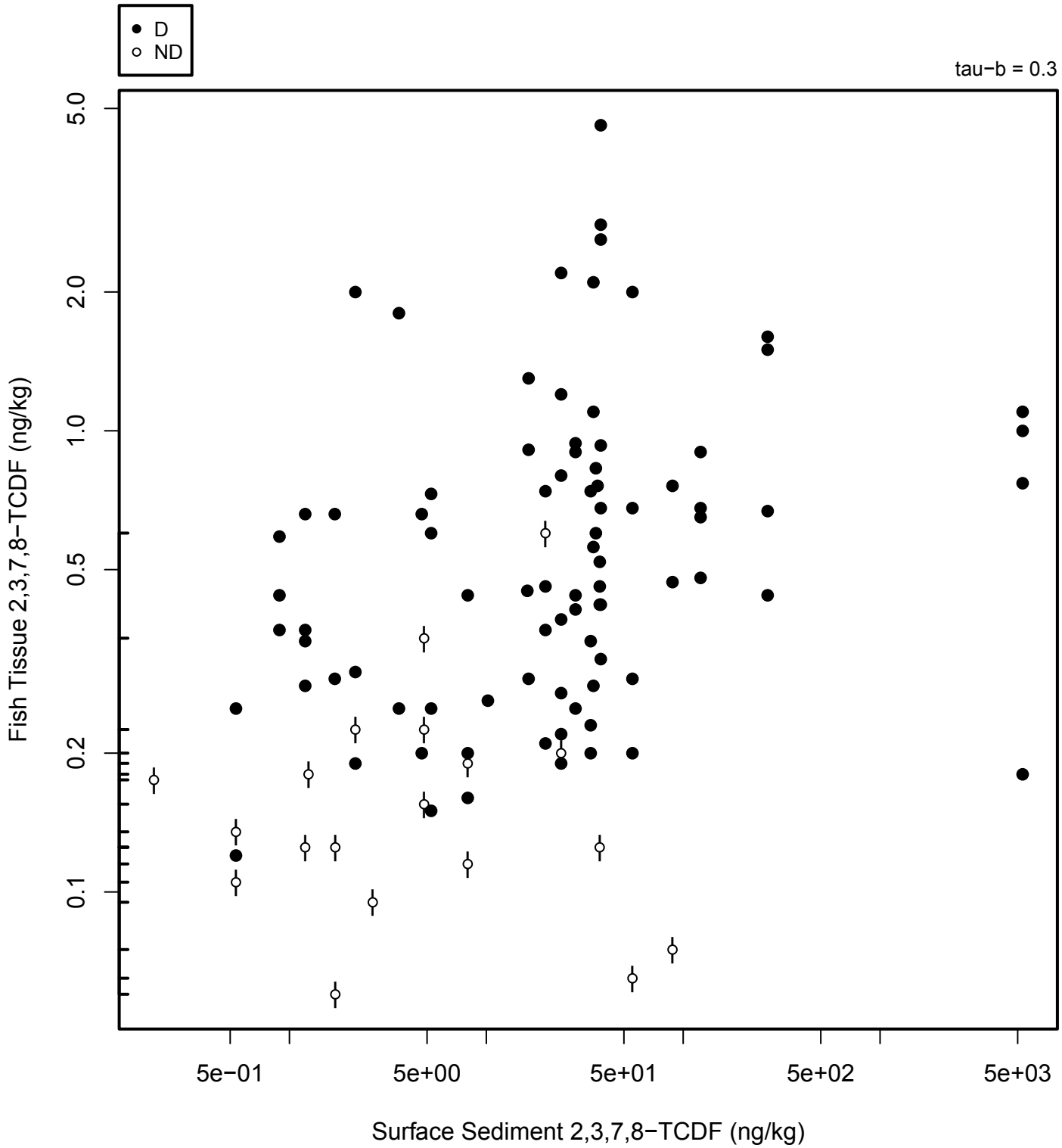
Notes:
D = detected
ND = nondetected; ½ detection limit used
Surface sediment concentrations represent averages of samples within 1000 m of each fish sample.
Inward ticks correspond to NDs in the x or y dimensions, as applicable.
Vertical or horizontal symbols represent the axis where data are censored. Censored Kendall's correlation statistic shown at top.

Figure 25
Relationships between Catfish Tissue and Surface Sediment Concentrations of 1,2,3,4,6,7,8−HpCDD (ng/kg, ND=½DL)
Bioaccumulation Technical Memo
SJRWP Superfund/MIMC and IPC



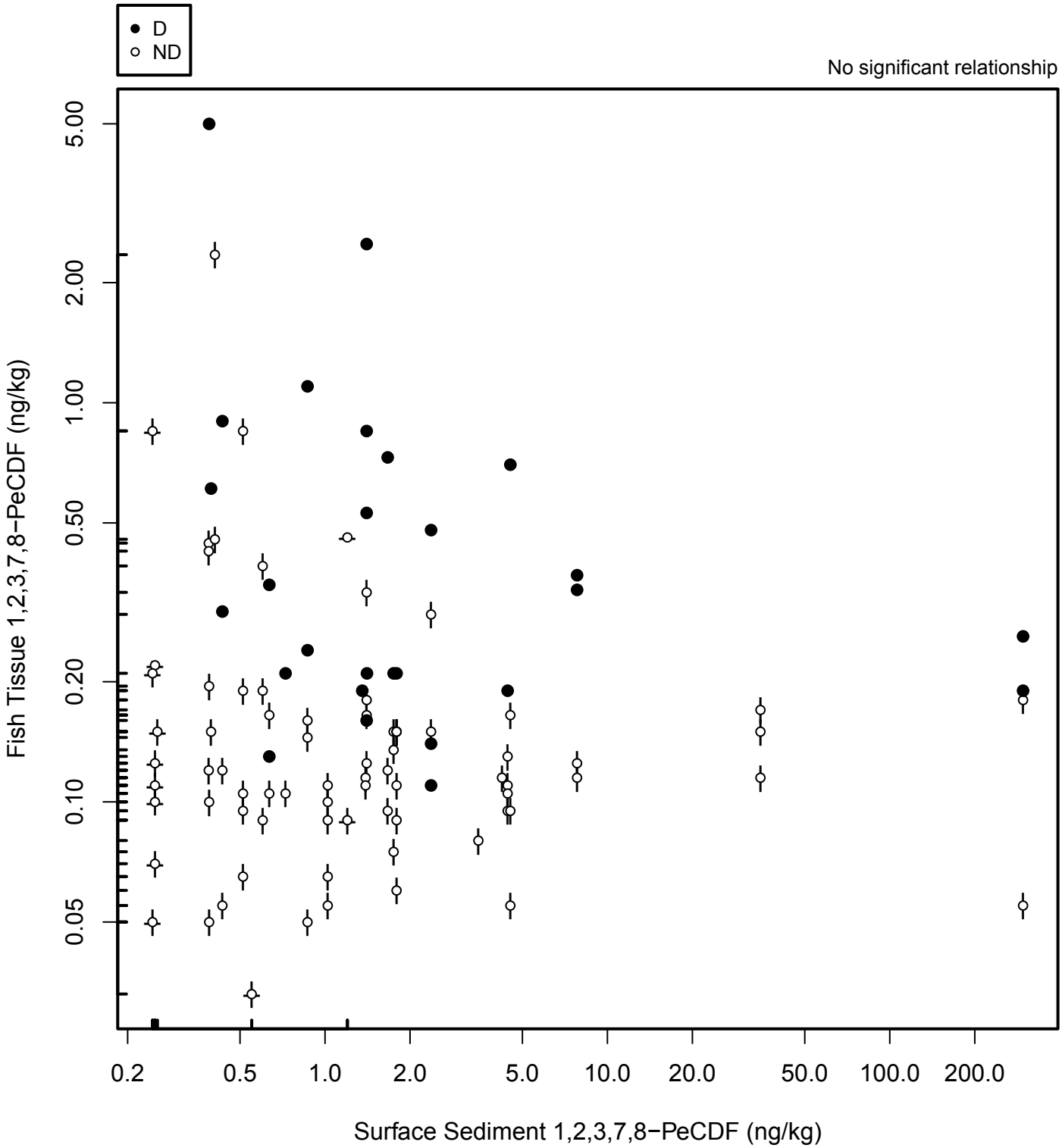
Notes:
D = detected
ND = nondetected; ½ detection limit used
Surface sediment concentrations represent averages of samples within 1000 m of each fish sample.
Inward ticks correspond to NDs in the x or y dimensions, as applicable.
Vertical or horizontal symbols represent the axis where data are censored. Censored Kendall's correlation statistic shown at top.

Figure 26
Relationships between Catfish Tissue and Surface Sediment Concentrations of OCDD (ng/kg, ND=½DL)
Bioaccumulation Technical Memo
SJRWP Superfund/MIMC and IPC



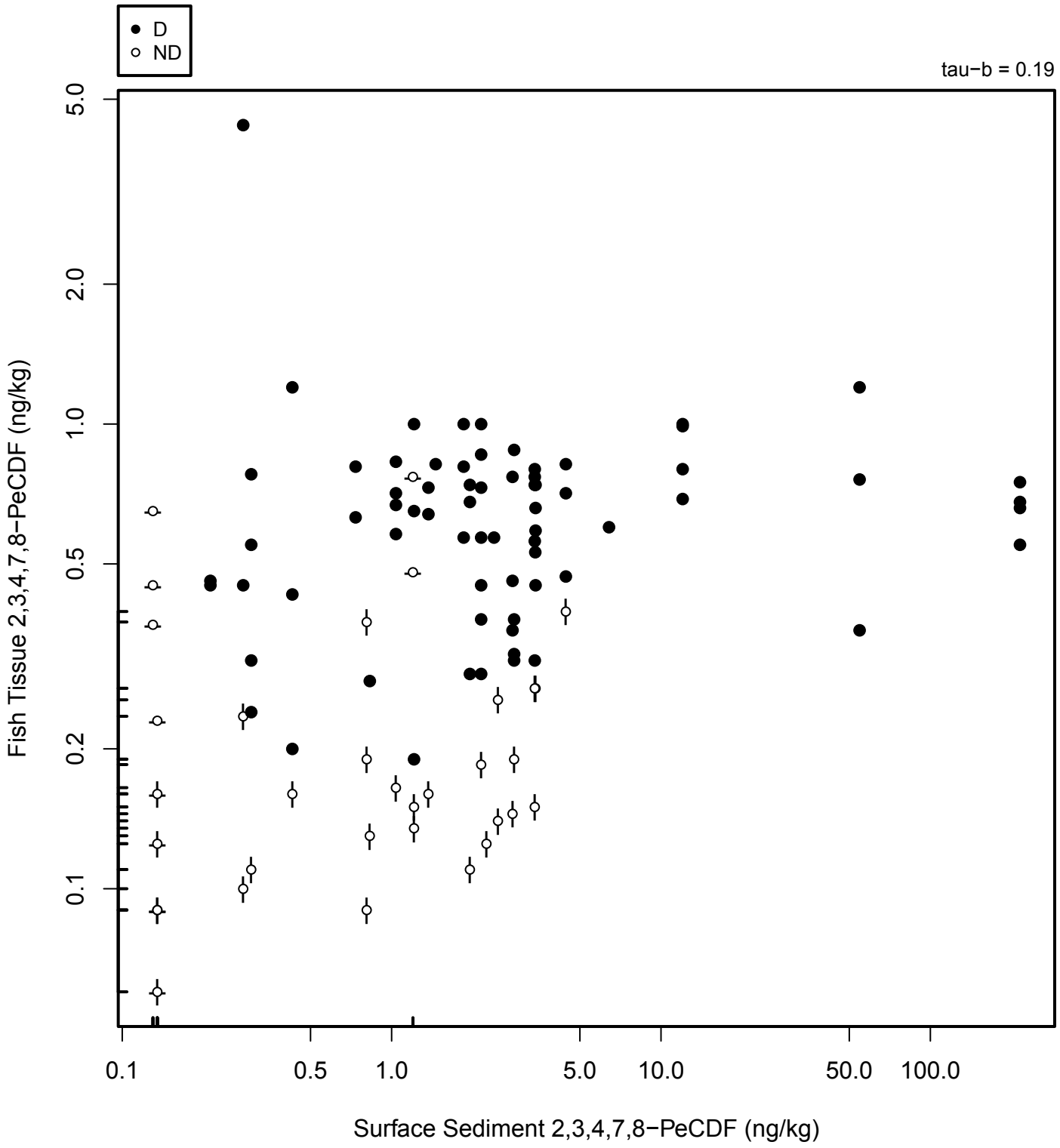
Notes:
D = detected
ND = nondetected; ½ detection limit used
Surface sediment concentrations represent averages of samples within 1000 m of each fish sample.
Inward ticks correspond to NDs in the x or y dimensions, as applicable.
Vertical or horizontal symbols represent the axis where data are censored. Censored Kendall's correlation statistic shown at top.

Figure 27
Relationships between Catfish Tissue and Surface Sediment Concentrations of 2,3,7,8−TCDF (ng/kg, ND=½DL)
Bioaccumulation Technical Memo
SJRWP Superfund/MIMC and IPC



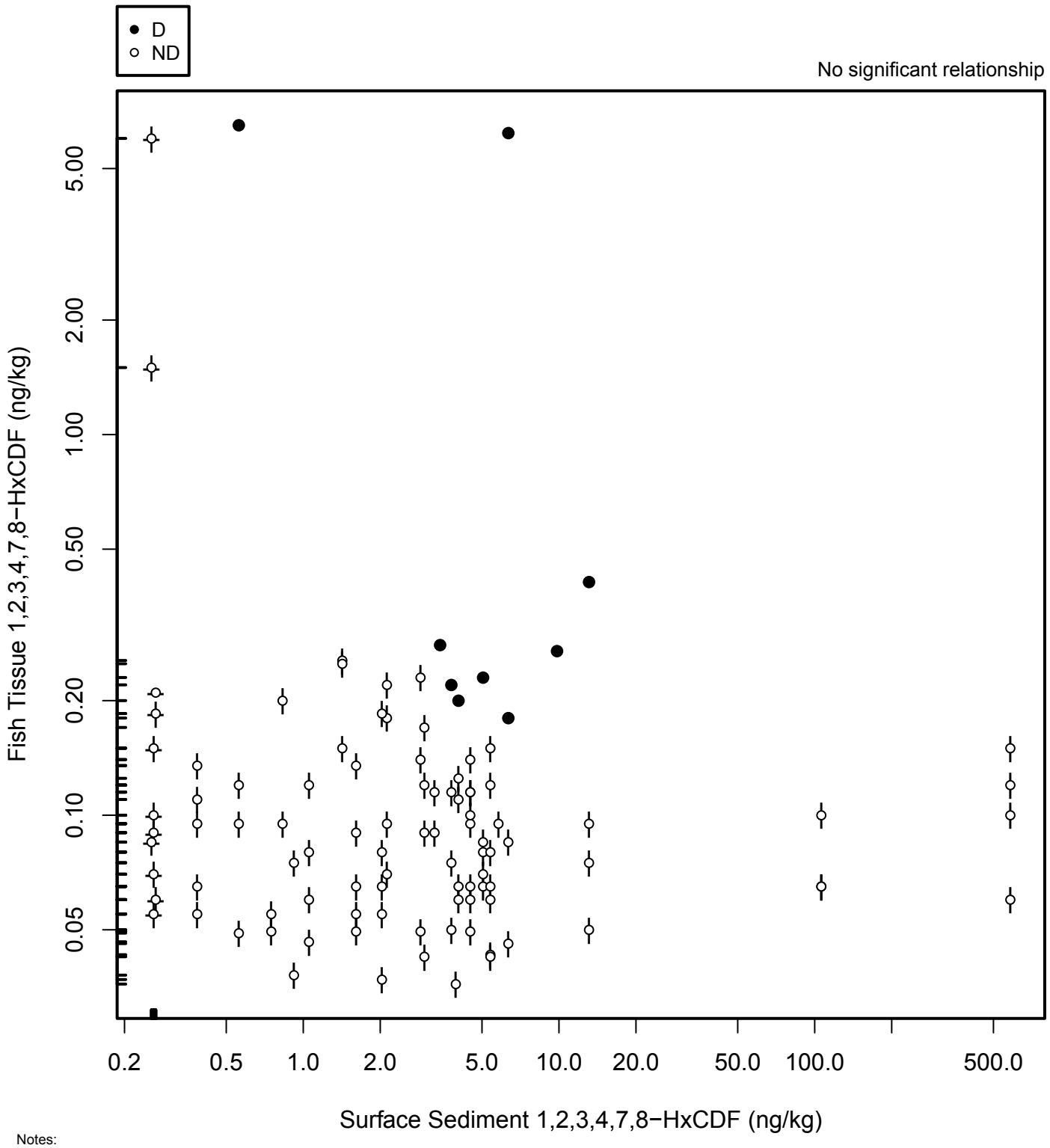
Notes:
D = detected
ND = nondetected; ½ detection limit used
Surface sediment concentrations represent averages of samples within 1000 m of each fish sample.
Inward ticks correspond to NDs in the x or y dimensions, as applicable.
Vertical or horizontal symbols represent the axis where data are censored. Censored Kendall's correlation statistic shown at top.

Figure 28
Relationships between Catfish Tissue and Surface Sediment Concentrations of 1,2,3,7,8−PeCDF (ng/kg, ND=½DL)
Bioaccumulation Technical Memo
SJRWP Superfund/MIMC and IPC



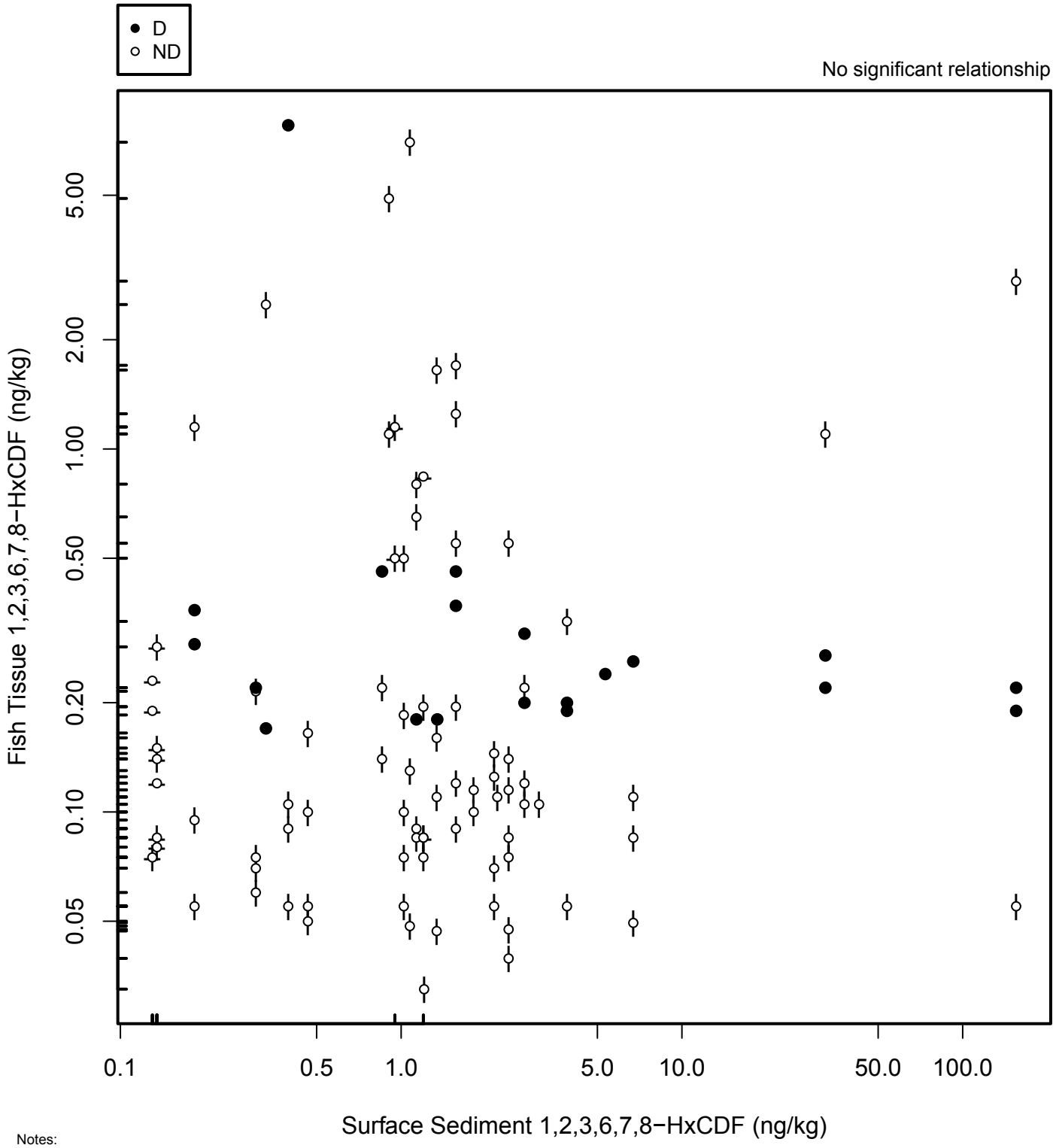
Notes:
D = detected
ND = nondetected; ½ detection limit used
Surface sediment concentrations represent averages of samples within 1000 m of each fish sample.
Inward ticks correspond to NDs in the x or y dimensions, as applicable.
Vertical or horizontal symbols represent the axis where data are censored. Censored Kendall's correlation statistic shown at top.

Figure 29
Relationships between Catfish Tissue and Surface Sediment Concentrations of 2,3,4,7,8−PeCDF (ng/kg, ND=½DL)
Bioaccumulation Technical Memo
SJRWP Superfund/MIMC and IPC



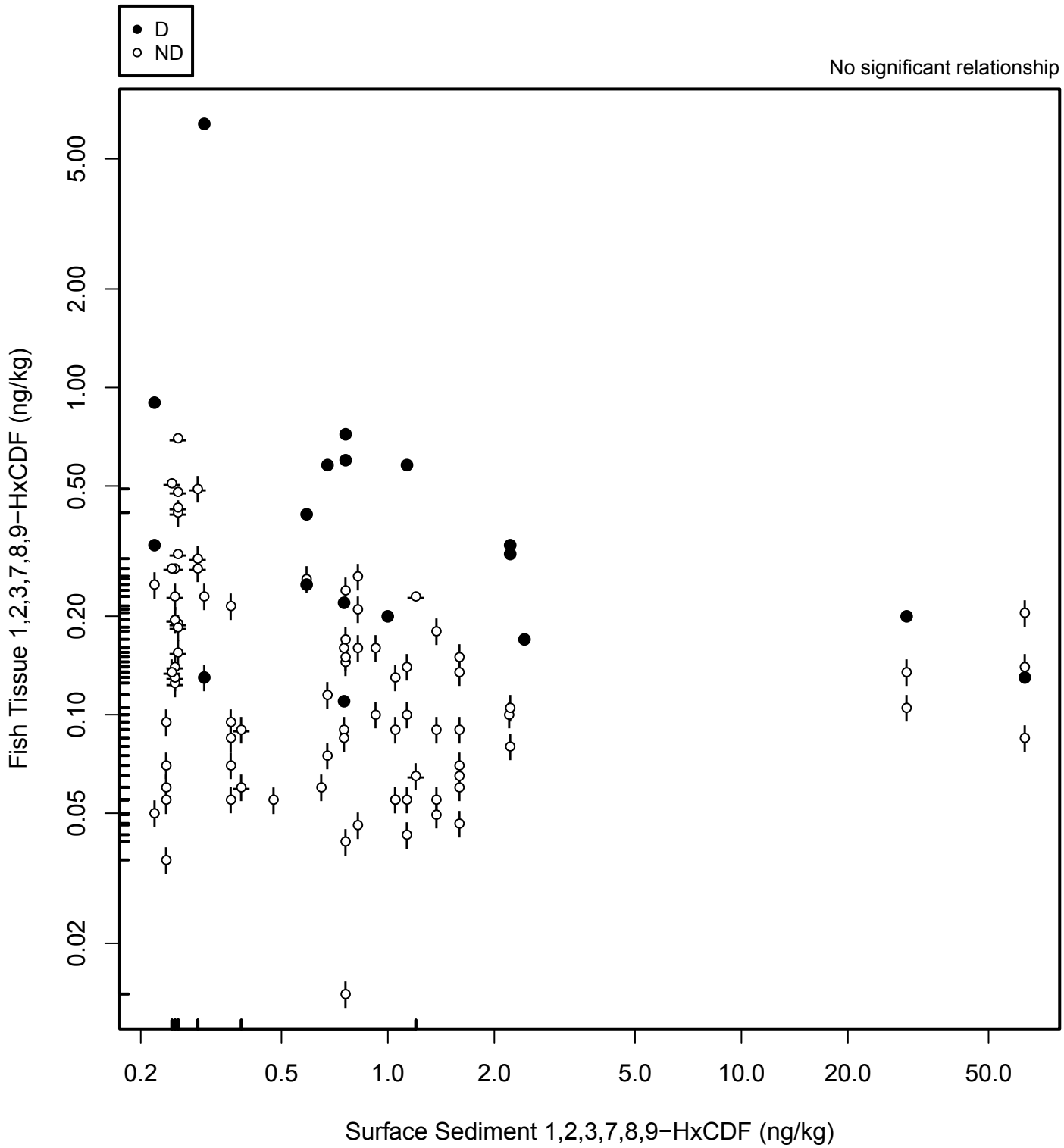
Notes:
D = detected
ND = nondetected; ½ detection limit used
Surface sediment concentrations represent averages of samples within 1000 m of each fish sample.
Inward ticks correspond to NDs in the x or y dimensions, as applicable.
Vertical or horizontal symbols represent the axis where data are censored. Censored Kendall's correlation statistic shown at top.

Figure 30
Relationships between Catfish Tissue and Surface Sediment Concentrations of 1,2,3,4,7,8−HxCDF (ng/kg, ND=½DL)
Bioaccumulation Technical Memo
SJRWP Superfund/MIMC and IPC



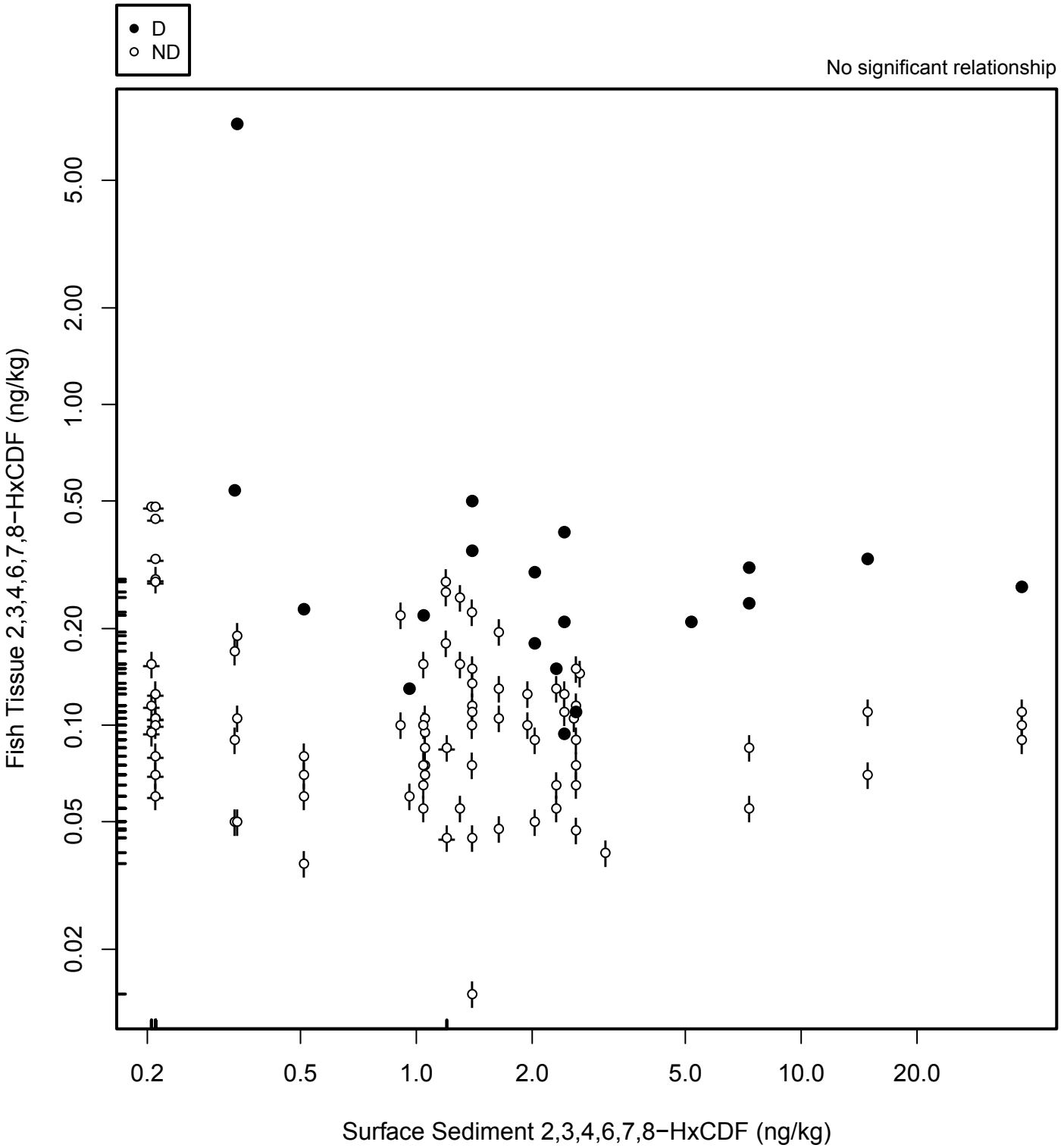
Notes:
D = detected
ND = nondetected; ½ detection limit used
Surface sediment concentrations represent averages of samples within 1000 m of each fish sample.
Inward ticks correspond to NDs in the x or y dimensions, as applicable.
Vertical or horizontal symbols represent the axis where data are censored. Censored Kendall's correlation statistic shown at top.

Figure 31
Relationships between Catfish Tissue and Surface Sediment Concentrations of 1,2,3,6,7,8−HxCDF (ng/kg, ND=½DL)
Bioaccumulation Technical Memo
SJRWP Superfund/MIMC and IPC



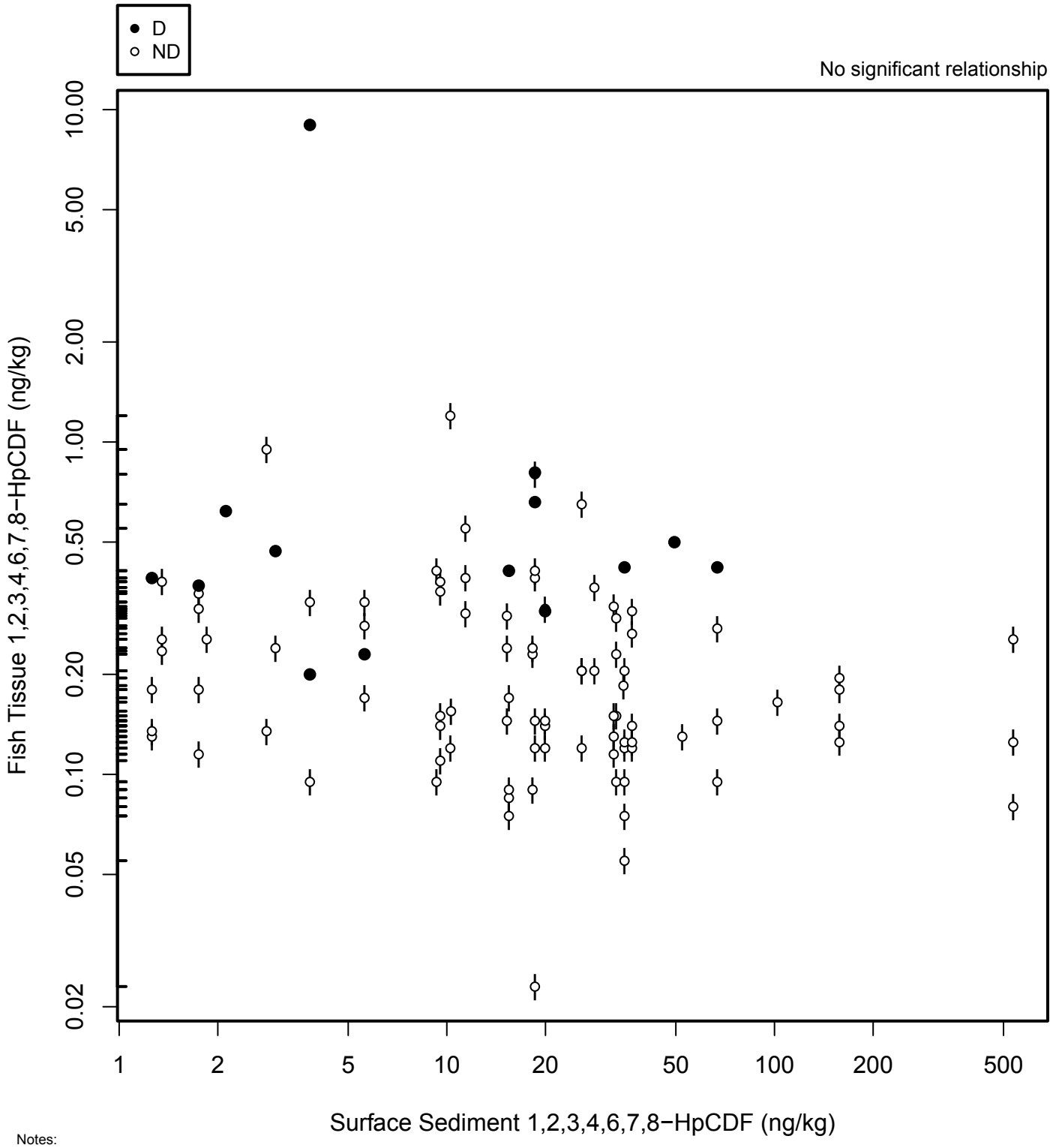
Notes:
D = detected
ND = nondetected; ½ detection limit used
Surface sediment concentrations represent averages of samples within 1000 m of each fish sample.
Inward ticks correspond to NDs in the x or y dimensions, as applicable.
Vertical or horizontal symbols represent the axis where data are censored. Censored Kendall's correlation statistic shown at top.

Figure 32
Relationships between Catfish Tissue and Surface Sediment Concentrations of 1,2,3,7,8,9−HxCDF (ng/kg, ND=½DL)
Bioaccumulation Technical Memo
SJRWP Superfund/MIMC and IPC



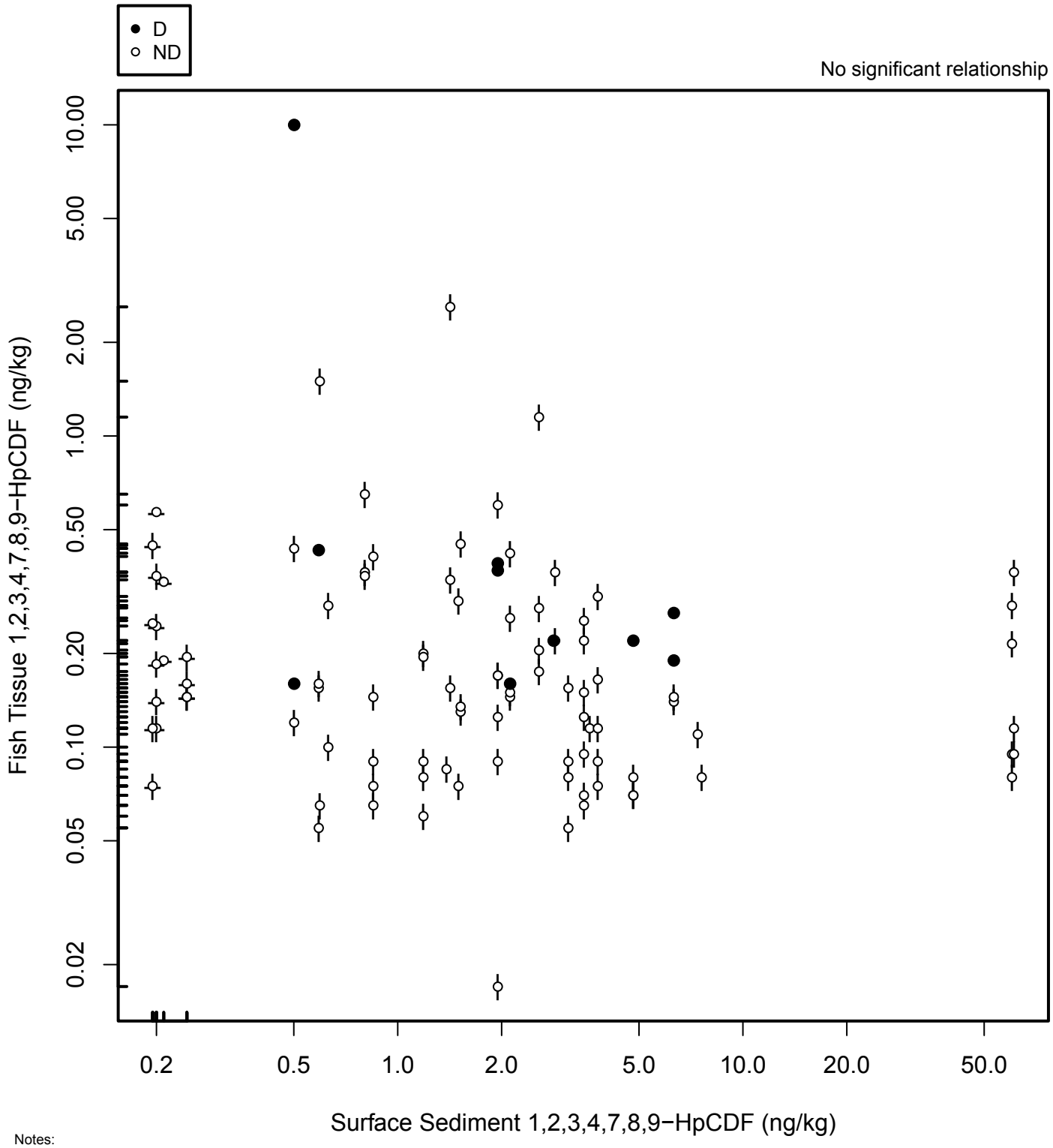
Notes:
D = detected
ND = nondetected; ½ detection limit used
Surface sediment concentrations represent averages of samples within 1000 m of each fish sample.
Inward ticks correspond to NDs in the x or y dimensions, as applicable.
Vertical or horizontal symbols represent the axis where data are censored. Censored Kendall's correlation statistic shown at top.

Figure 33
Relationships between Catfish Tissue and Surface Sediment Concentrations of 2,3,4,6,7,8−HxCDF (ng/kg, ND=½DL)
Bioaccumulation Technical Memo
SJRWP Superfund/MIMC and IPC



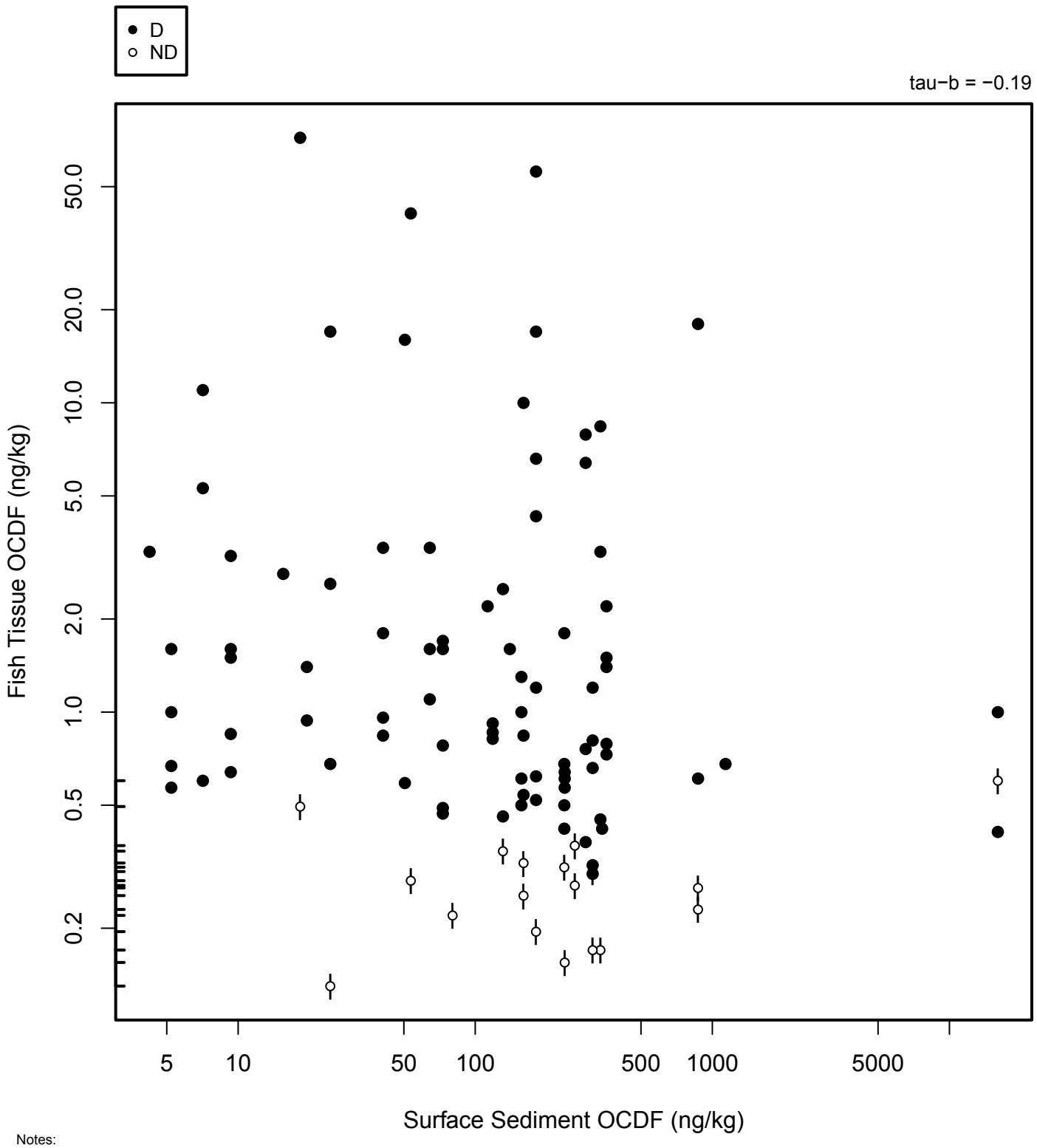
Notes:
D = detected
ND = nondetected; ½ detection limit used
Surface sediment concentrations represent averages of samples within 1000 m of each fish sample.
Inward ticks correspond to NDs in the x or y dimensions, as applicable.
Vertical or horizontal symbols represent the axis where data are censored. Censored Kendall's correlation statistic shown at top.

Figure 34
Relationships between Catfish Tissue and Surface Sediment Concentrations of 1,2,3,4,6,7,8−HpCDF (ng/kg, ND=½DL)
Bioaccumulation Technical Memo
SJRWP Superfund/MIMC and IPC



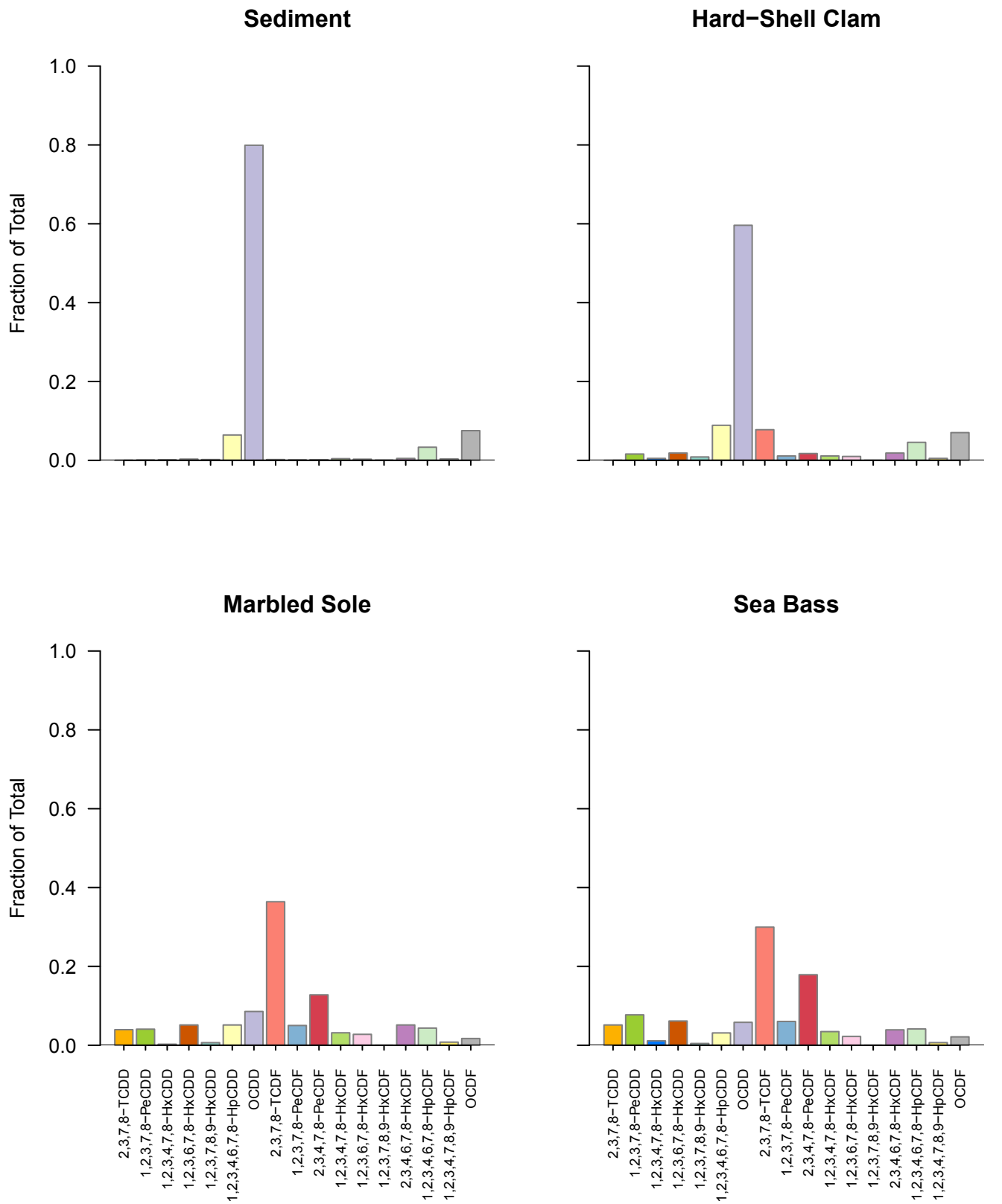
Notes:
D = detected
ND = nondetected; ½ detection limit used
Surface sediment concentrations represent averages of samples within 1000 m of each fish sample.
Inward ticks correspond to NDs in the x or y dimensions, as applicable.
Vertical or horizontal symbols represent the axis where data are censored. Censored Kendall's correlation statistic shown at top.

Figure 35
Relationships between Catfish Tissue and Surface Sediment Concentrations of 1,2,3,4,7,8,9−HpCDF (ng/kg, ND=½DL)
Bioaccumulation Technical Memo
SJRWP Superfund/MIMC and IPC



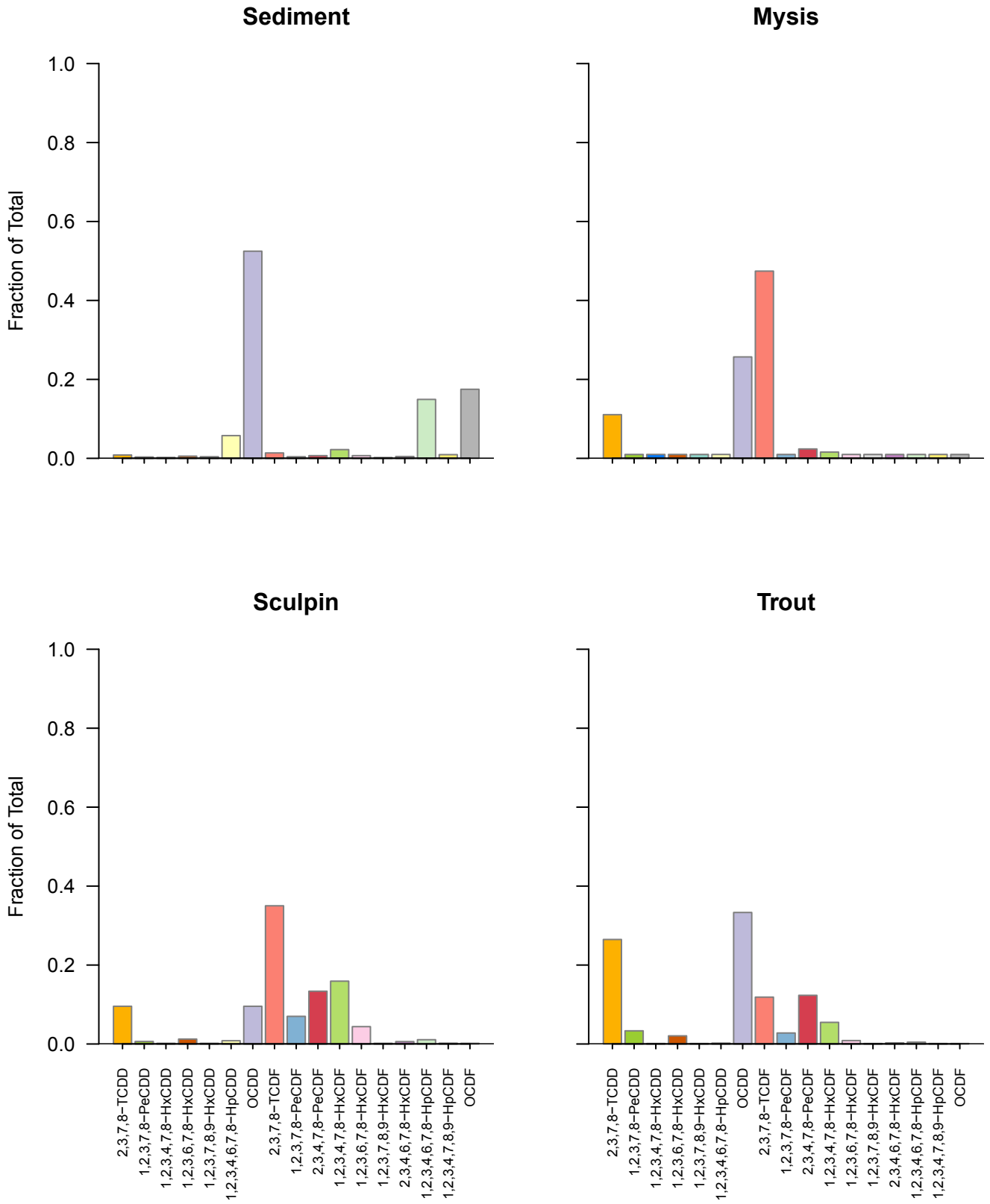
Notes:
D = detected
ND = nondetected; ½ detection limit used
Surface sediment concentrations represent averages of samples within 1000 m of each fish sample.
Inward ticks correspond to NDs in the x or y dimensions, as applicable.
Vertical or horizontal symbols represent the axis where data are censored. Censored Kendall's correlation statistic shown at top.

Figure 36
Relationships between Catfish Tissue and Surface Sediment Concentrations of OCDF (ng/kg, ND=½DL)
Bioaccumulation Technical Memo
SJRWP Superfund/MIMC and IPC



Note:
Colors are used only to assist visual comparisons and have no intrinsic meaning.

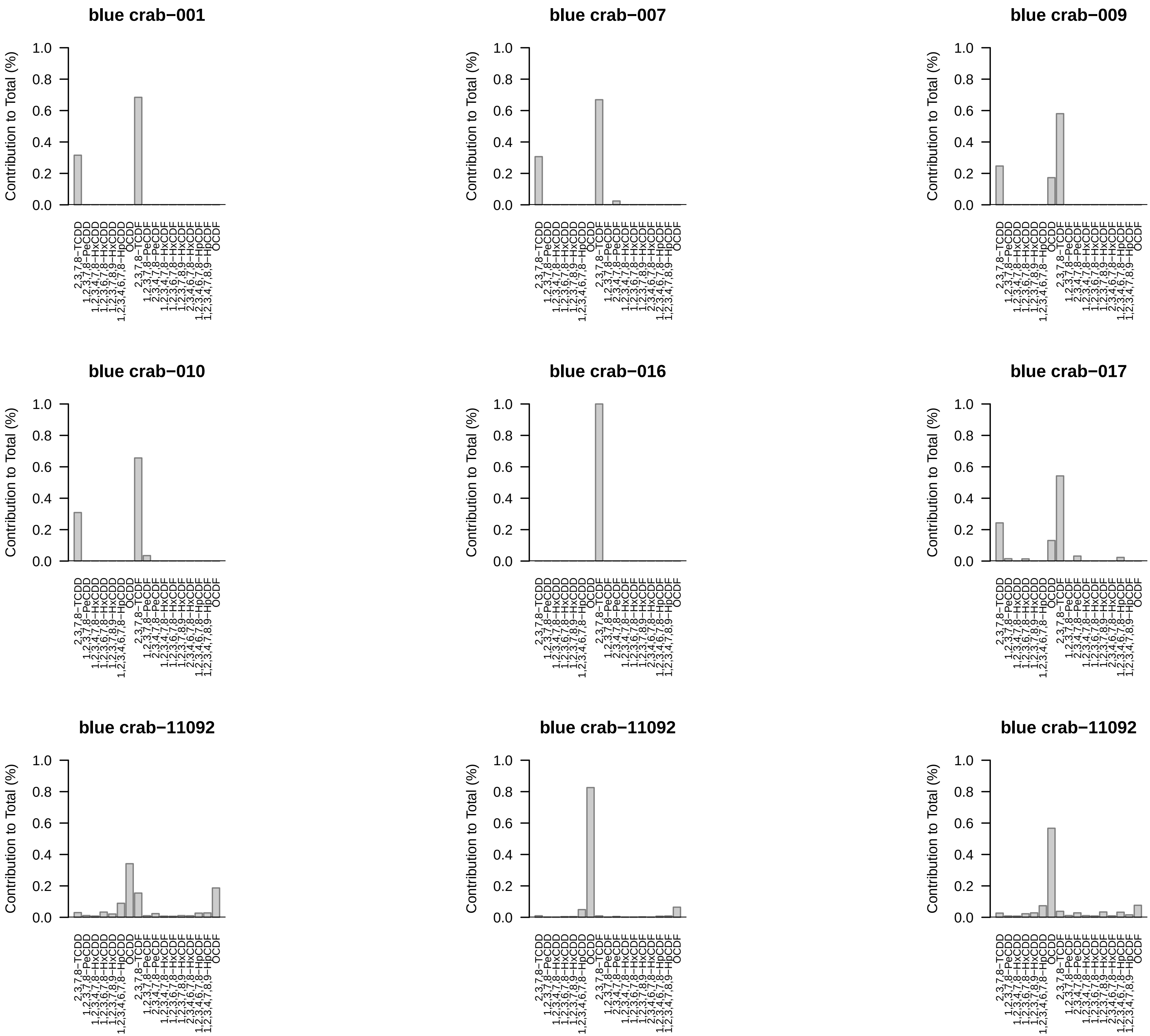
Figure 37
Dioxin and Furan Patterns in Sediment and Aquatic Biota from Tokyo Bay, Japan (Naito et al. 2003)
Bioaccumulation Technical Memo
SJRWP Superfund/MIMC and IPC

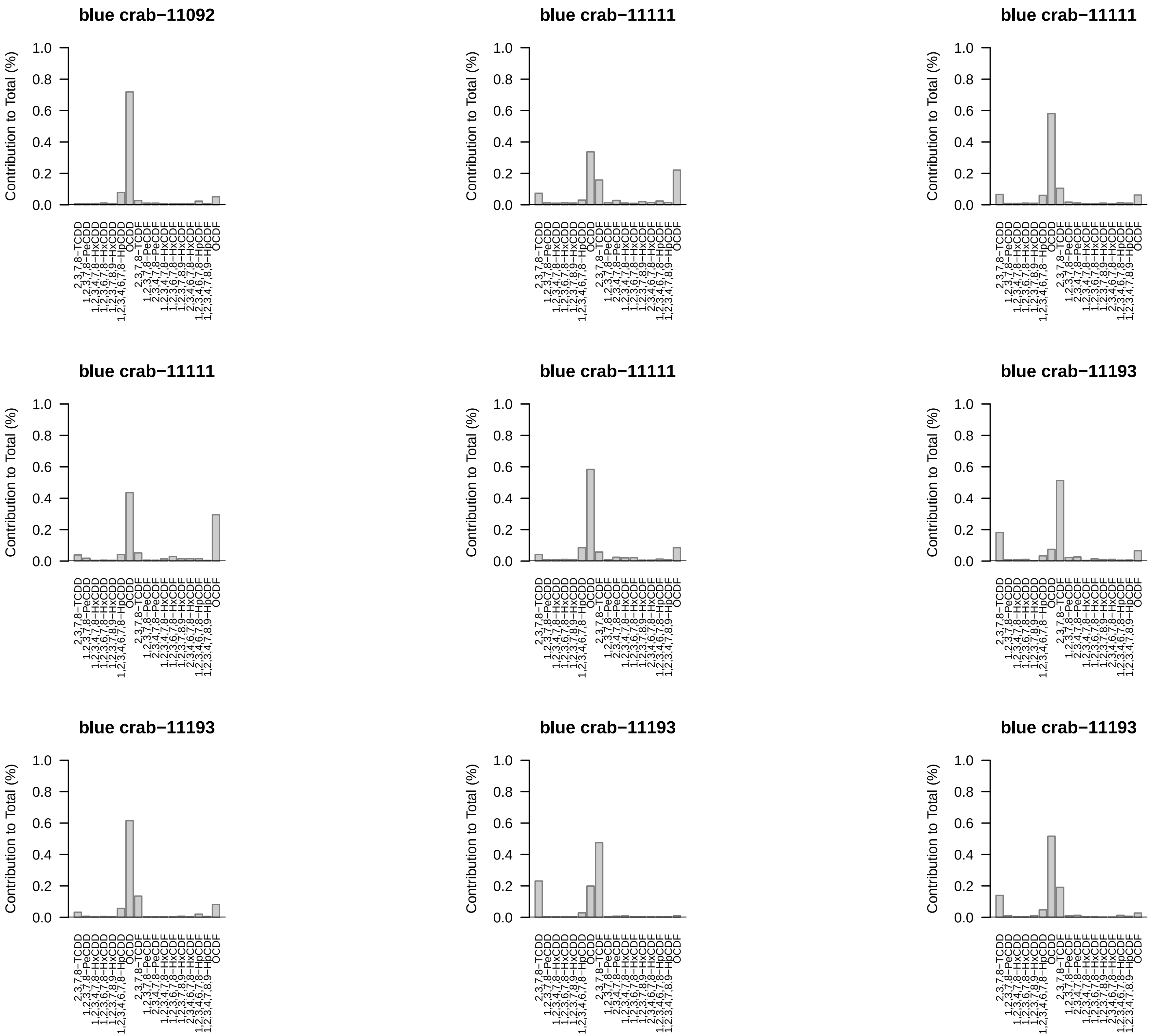


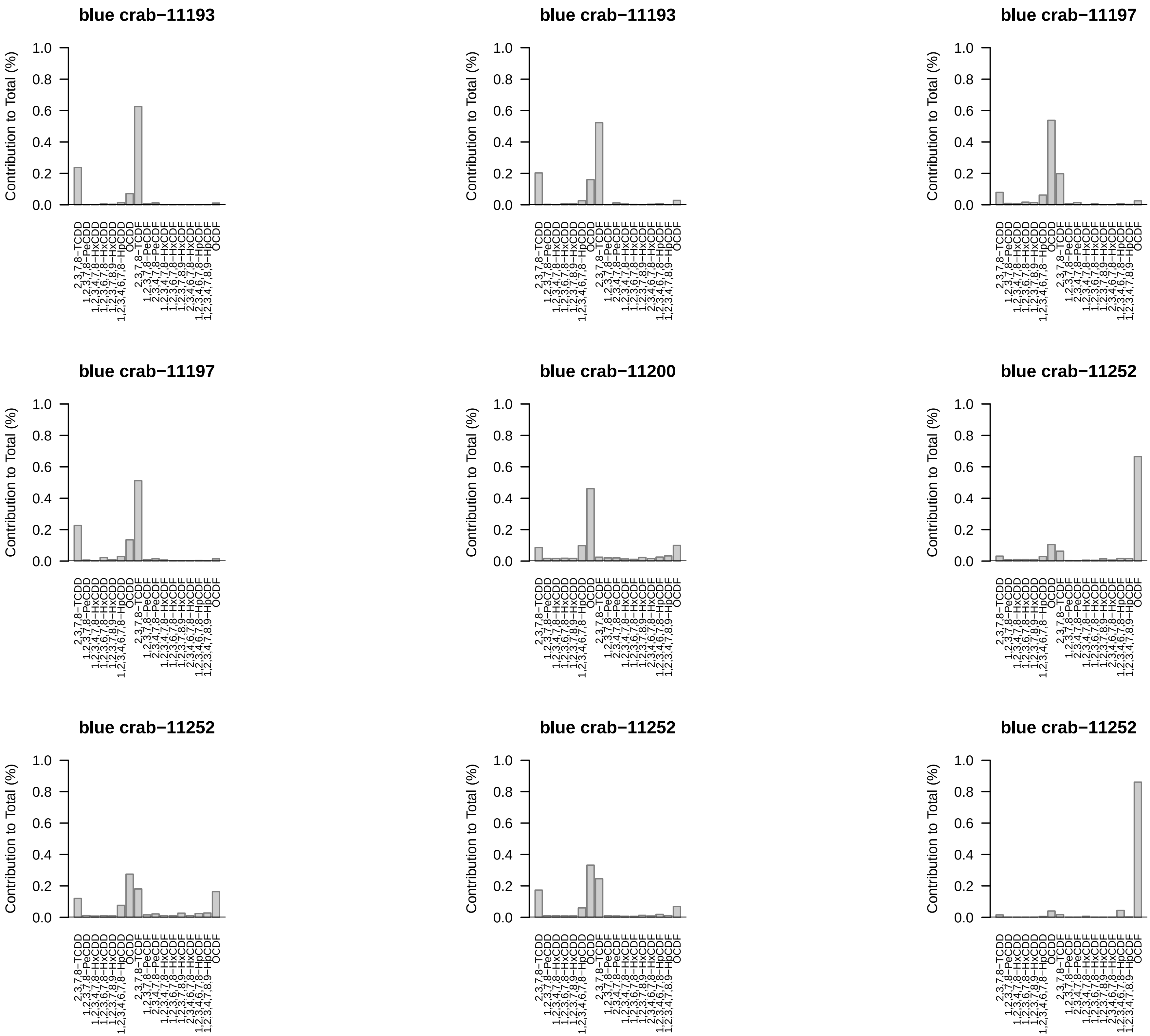
Note:
Colors are used only to assist visual comparisons and have no intrinsic meaning.

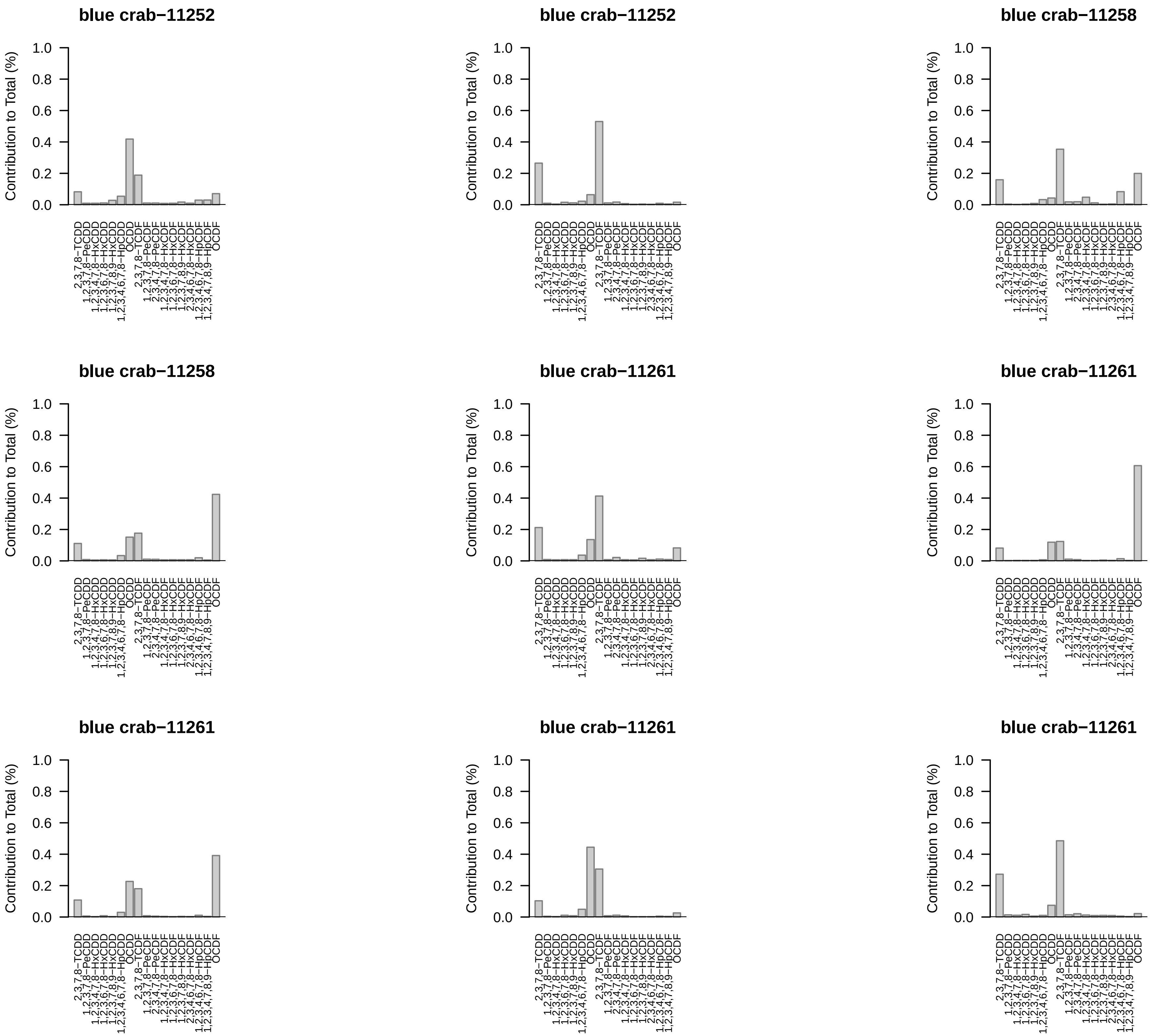
Figure 38
Dioxin and Furan Patterns in Sediment and Aquatic Biota from Lake Ontario, Canada (Niimi 1996)
Bioaccumulation Technical Memo
SJRWP Superfund/MIMC and IPC

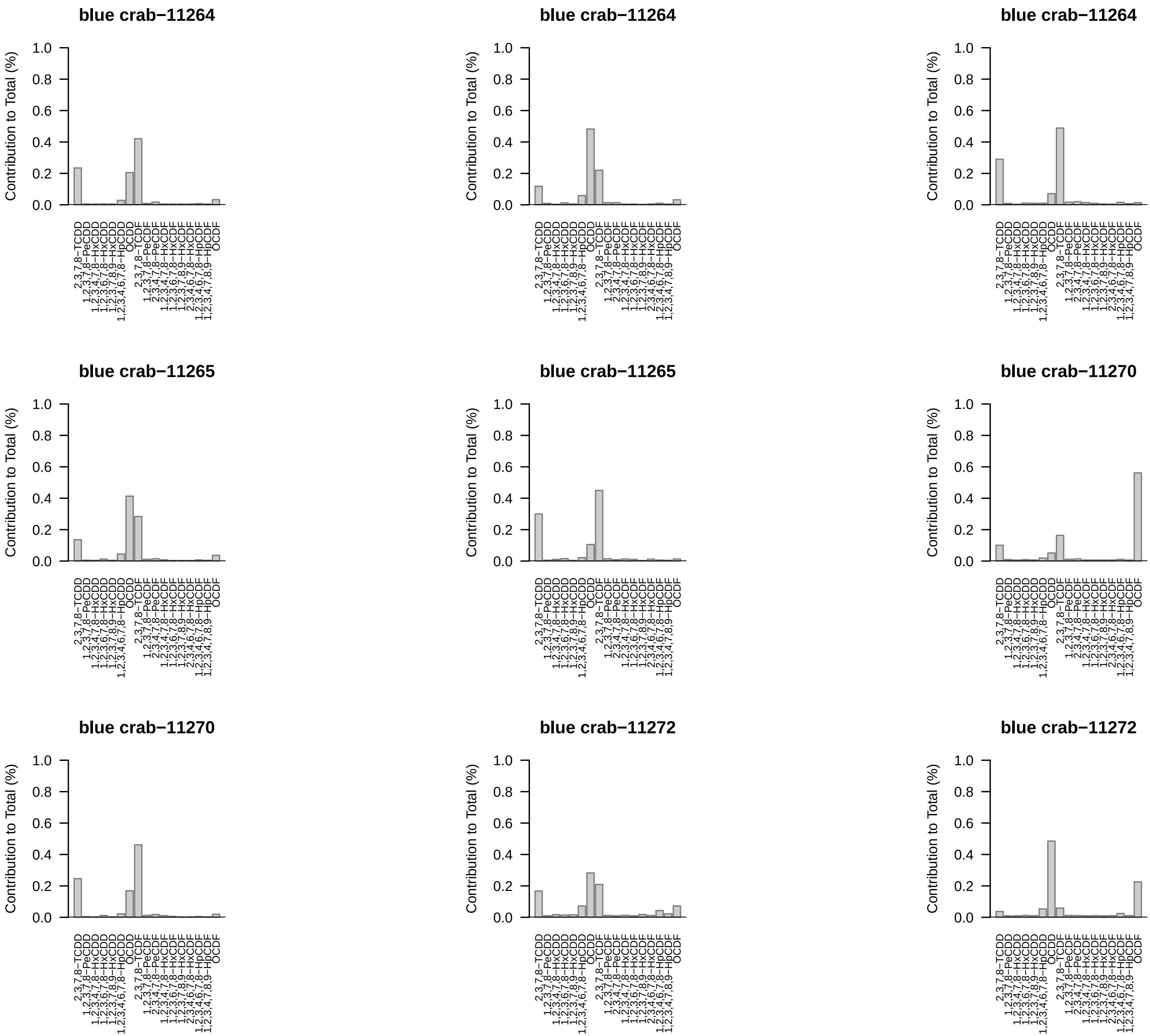
APPENDIX A
DIOXIN AND FURAN PROFILES FOR ALL CRAB AND FISH SAMPLES COLLECTED WITHIN THE HOUSTON SHIP CHANNEL

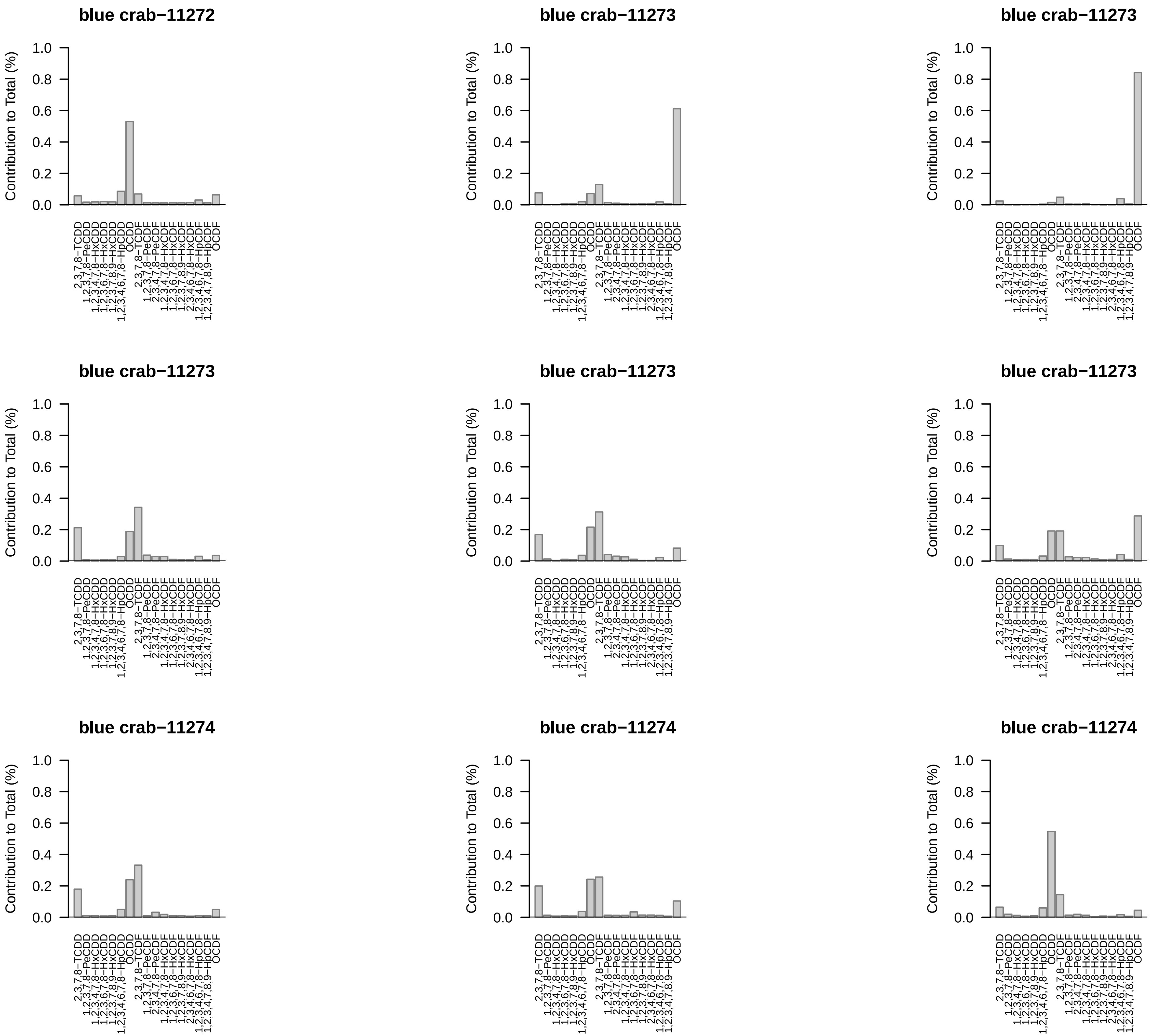

blue crab−001
blue crab−007
blue crab−009
blue crab−010
blue crab−016
blue crab−017
blue crab−11092
blue crab−11092
blue crab−11092
Contribution to Total (%)
0.0
0.2
0.4
0.6
0.8
1.0
2,3,7,8−TCDD
1,2,3,7,8−PeCDD
1,2,3,4,7,8−HxCDD
1,2,3,6,7,8−HxCDD
1,2,3,7,8,9−HxCDD
1,2,3,4,6,7,8−HpCDD
OCDD
2,3,7,8−TCDF
1,2,3,7,8−PeCDF
2,3,4,7,8−PeCDF
1,2,3,4,7,8−HxCDF
1,2,3,6,7,8−HxCDF
1,2,3,7,8,9−HxCDF
2,3,4,6,7,8−HxCDF
1,2,3,4,6,7,8−HpCDF
1,2,3,4,7,8,9−HpCDF
OCDF

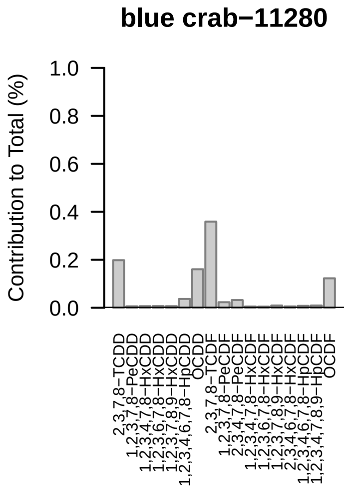

blue crab−11092
blue crab−11111
blue crab−11111
blue crab−11111
blue crab−11111
blue crab−11193
blue crab−11193
blue crab−11193
blue crab−11193
Contribution to Total (%)
0.0
0.2
0.4
0.6
0.8
1.0
2,3,7,8−TCDD
1,2,3,7,8−PeCDD
1,2,3,4,7,8−HxCDD
1,2,3,6,7,8−HxCDD
1,2,3,7,8,9−HxCDD
1,2,3,4,6,7,8−HpCDD
OCDD
2,3,7,8−TCDF
1,2,3,7,8−PeCDF
2,3,4,7,8−PeCDF
1,2,3,4,7,8−HxCDF
1,2,3,6,7,8−HxCDF
1,2,3,7,8,9−HxCDF
2,3,4,6,7,8−HxCDF
1,2,3,4,6,7,8−HpCDF
1,2,3,4,7,8,9−HpCDF
OCDF

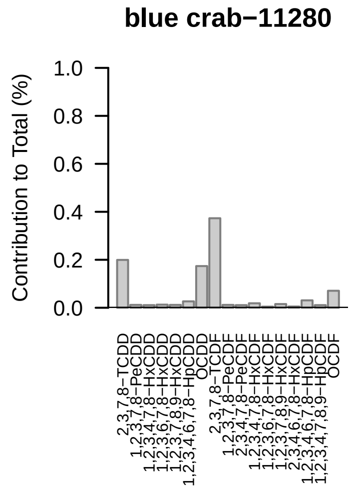

blue crab−11193
blue crab−11193
blue crab−11197
blue crab−11197
blue crab−11200
blue crab−11252
blue crab−11252
blue crab−11252
blue crab−11252
Contribution to Total (%)
0.0
0.2
0.4
0.6
0.8
1.0
2,3,7,8−TCDD
1,2,3,7,8−PeCDD
1,2,3,4,7,8−HxCDD
1,2,3,6,7,8−HxCDD
1,2,3,7,8,9−HxCDD
1,2,3,4,6,7,8−HpCDD
OCDD
2,3,7,8−TCDF
1,2,3,7,8−PeCDF
2,3,4,7,8−PeCDF
1,2,3,4,7,8−HxCDF
1,2,3,6,7,8−HxCDF
1,2,3,7,8,9−HxCDF
2,3,4,6,7,8−HxCDF
1,2,3,4,6,7,8−HpCDF
1,2,3,4,7,8,9−HpCDF
OCDF

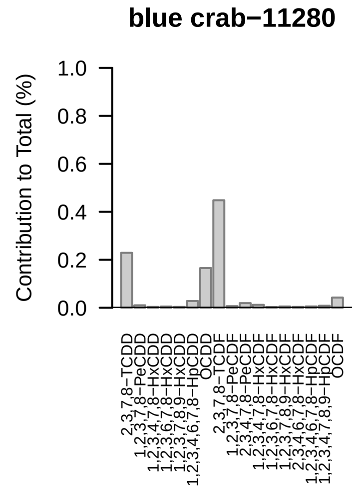

blue crab−11252
blue crab−11252
blue crab−11258
blue crab−11258
blue crab−11261
blue crab−11261
blue crab−11261
blue crab−11261
blue crab−11261
Contribution to Total (%)
0.0
0.2
0.4
0.6
0.8
1.0
2,3,7,8−TCDD
1,2,3,7,8−PeCDD
1,2,3,4,7,8−HxCDD
1,2,3,6,7,8−HxCDD
1,2,3,7,8,9−HxCDD
1,2,3,4,6,7,8−HpCDD
OCDD
2,3,7,8−TCDF
1,2,3,7,8−PeCDF
2,3,4,7,8−PeCDF
1,2,3,4,7,8−HxCDF
1,2,3,6,7,8−HxCDF
1,2,3,7,8,9−HxCDF
2,3,4,6,7,8−HxCDF
1,2,3,4,6,7,8−HpCDF
1,2,3,4,7,8,9−HpCDF
OCDF

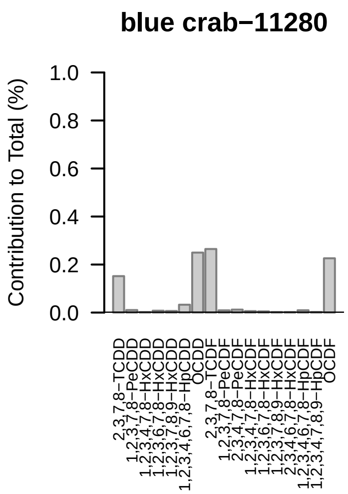

blue crab−11264
blue crab−11264
blue crab−11264
blue crab−11265
blue crab−11265
blue crab−11270
blue crab−11270
blue crab−11272
blue crab−11272
Contribution to Total (%)
0.0
0.2
0.4
0.6
0.8
1.0
2,3,7,8−TCDD
1,2,3,7,8−PeCDD
1,2,3,4,7,8−HxCDD
1,2,3,6,7,8−HxCDD
1,2,3,7,8,9−HxCDD
1,2,3,4,6,7,8−HpCDD
OCDD
2,3,7,8−TCDF
1,2,3,7,8−PeCDF
2,3,4,7,8−PeCDF
1,2,3,4,7,8−HxCDF
1,2,3,6,7,8−HxCDF
1,2,3,7,8,9−HxCDF
2,3,4,6,7,8−HxCDF
1,2,3,4,6,7,8−HpCDF
1,2,3,4,7,8,9−HpCDF
OCDF

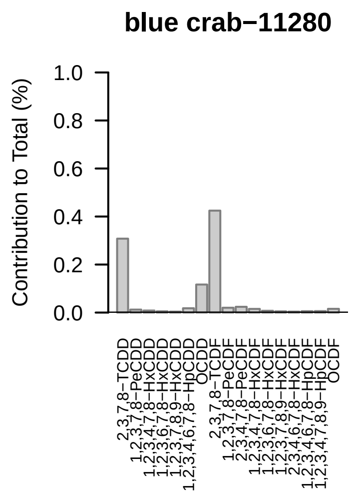

blue crab−11272
blue crab−11273
blue crab−11273
blue crab−11273
blue crab−11273
blue crab−11273
blue crab−11274
blue crab−11274
blue crab−11274
Contribution to Total (%)
0.0
0.2
0.4
0.6
0.8
1.0
2,3,7,8−TCDD
1,2,3,7,8−PeCDD
1,2,3,4,7,8−HxCDD
1,2,3,6,7,8−HxCDD
1,2,3,7,8,9−HxCDD
1,2,3,4,6,7,8−HpCDD
OCDD
2,3,7,8−TCDF
1,2,3,7,8−PeCDF
2,3,4,7,8−PeCDF
1,2,3,4,7,8−HxCDF
1,2,3,6,7,8−HxCDF
1,2,3,7,8,9−HxCDF
2,3,4,6,7,8−HxCDF
1,2,3,4,6,7,8−HpCDF
1,2,3,4,7,8,9−HpCDF
OCDF

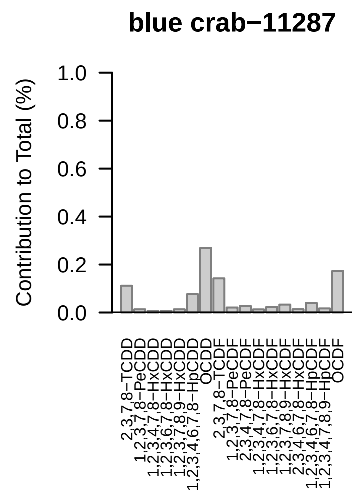

blue crab−11280
Contribution to Total (%)
0.0 0.2 0.4 0.6 0.8 1.0
2,3,7,8−TCDD
1,2,3,7,8−PeCDD
1,2,3,4,7,8−HxCDD
1,2,3,6,7,8−HxCDD
1,2,3,7,8,9−HxCDD
1,2,3,4,6,7,8−HpCDD
OCDD
2,3,7,8−TCDF
1,2,3,7,8−PeCDF
2,3,4,7,8−PeCDF
1,2,3,4,7,8−HxCDF
1,2,3,6,7,8−HxCDF
1,2,3,7,8,9−HxCDF
2,3,4,6,7,8−HxCDF
1,2,3,4,6,7,8−HpCDF
1,2,3,4,7,8,9−HpCDF
OCDF

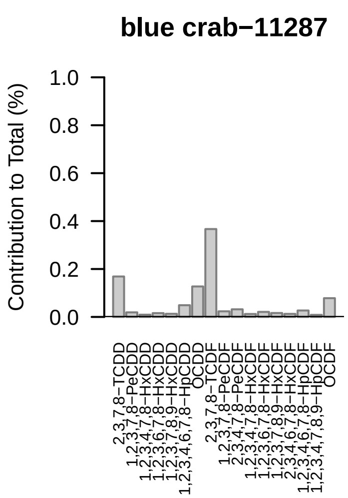

blue crab−11280
Contribution to Total (%)
0.0 0.2 0.4 0.6 0.8 1.0
2,3,7,8−TCDD
1,2,3,7,8−PeCDD
1,2,3,4,7,8−HxCDD
1,2,3,6,7,8−HxCDD
1,2,3,7,8,9−HxCDD
1,2,3,4,6,7,8−HpCDD
OCDD
2,3,7,8−TCDF
1,2,3,7,8−PeCDF
2,3,4,7,8−PeCDF
1,2,3,4,7,8−HxCDF
1,2,3,6,7,8−HxCDF
1,2,3,7,8,9−HxCDF
2,3,4,6,7,8−HxCDF
1,2,3,4,6,7,8−HpCDF
1,2,3,4,7,8,9−HpCDF
OCDF

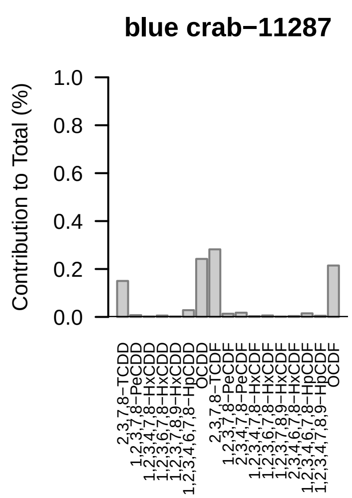

blue crab−11280
Contribution to Total (%)
0.0 0.2 0.4 0.6 0.8 1.0
2,3,7,8−TCDD
1,2,3,7,8−PeCDD
1,2,3,4,7,8−HxCDD
1,2,3,6,7,8−HxCDD
1,2,3,7,8,9−HxCDD
1,2,3,4,6,7,8−HpCDD
OCDD
2,3,7,8−TCDF
1,2,3,7,8−PeCDF
2,3,4,7,8−PeCDF
1,2,3,4,7,8−HxCDF
1,2,3,6,7,8−HxCDF
1,2,3,7,8,9−HxCDF
2,3,4,6,7,8−HxCDF
1,2,3,4,6,7,8−HpCDF
1,2,3,4,7,8,9−HpCDF
OCDF

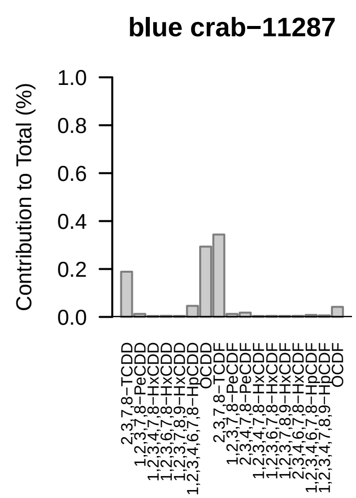

blue crab−11280
Contribution to Total (%)
0.0 0.2 0.4 0.6 0.8 1.0
2,3,7,8−TCDD
1,2,3,7,8−PeCDD
1,2,3,4,7,8−HxCDD
1,2,3,6,7,8−HxCDD
1,2,3,7,8,9−HxCDD
1,2,3,4,6,7,8−HpCDD
OCDD
2,3,7,8−TCDF
1,2,3,7,8−PeCDF
2,3,4,7,8−PeCDF
1,2,3,4,7,8−HxCDF
1,2,3,6,7,8−HxCDF
1,2,3,7,8,9−HxCDF
2,3,4,6,7,8−HxCDF
1,2,3,4,6,7,8−HpCDF
1,2,3,4,7,8,9−HpCDF
OCDF

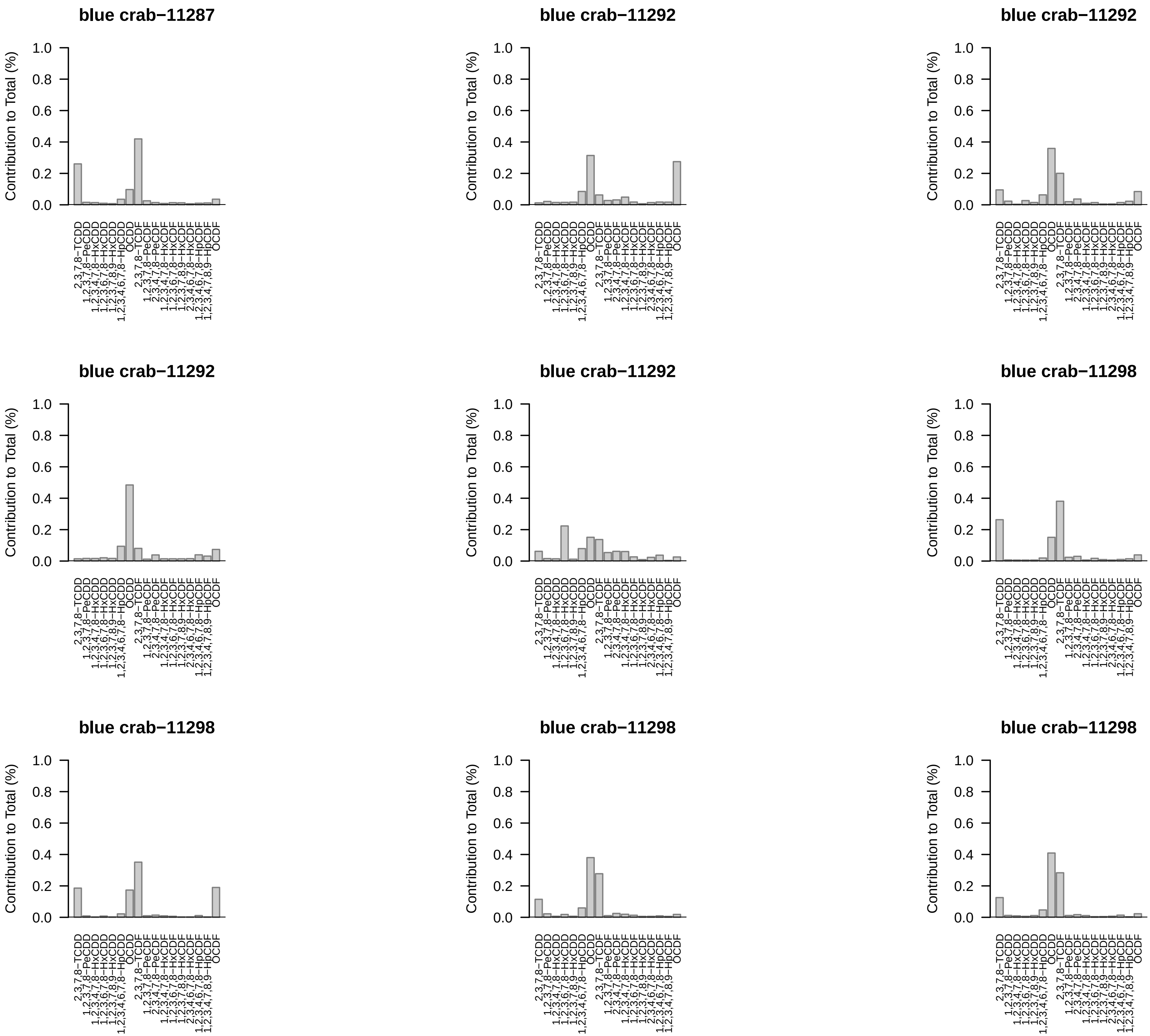

blue crab−11280
Contribution to Total (%)
0.0 0.2 0.4 0.6 0.8 1.0
2,3,7,8−TCDD
1,2,3,7,8−PeCDD
1,2,3,4,7,8−HxCDD
1,2,3,6,7,8−HxCDD
1,2,3,7,8,9−HxCDD
1,2,3,4,6,7,8−HpCDD
OCDD
2,3,7,8−TCDF
1,2,3,7,8−PeCDF
2,3,4,7,8−PeCDF
1,2,3,4,7,8−HxCDF
1,2,3,6,7,8−HxCDF
1,2,3,7,8,9−HxCDF
2,3,4,6,7,8−HxCDF
1,2,3,4,6,7,8−HpCDF
1,2,3,4,7,8,9−HpCDF
OCDF

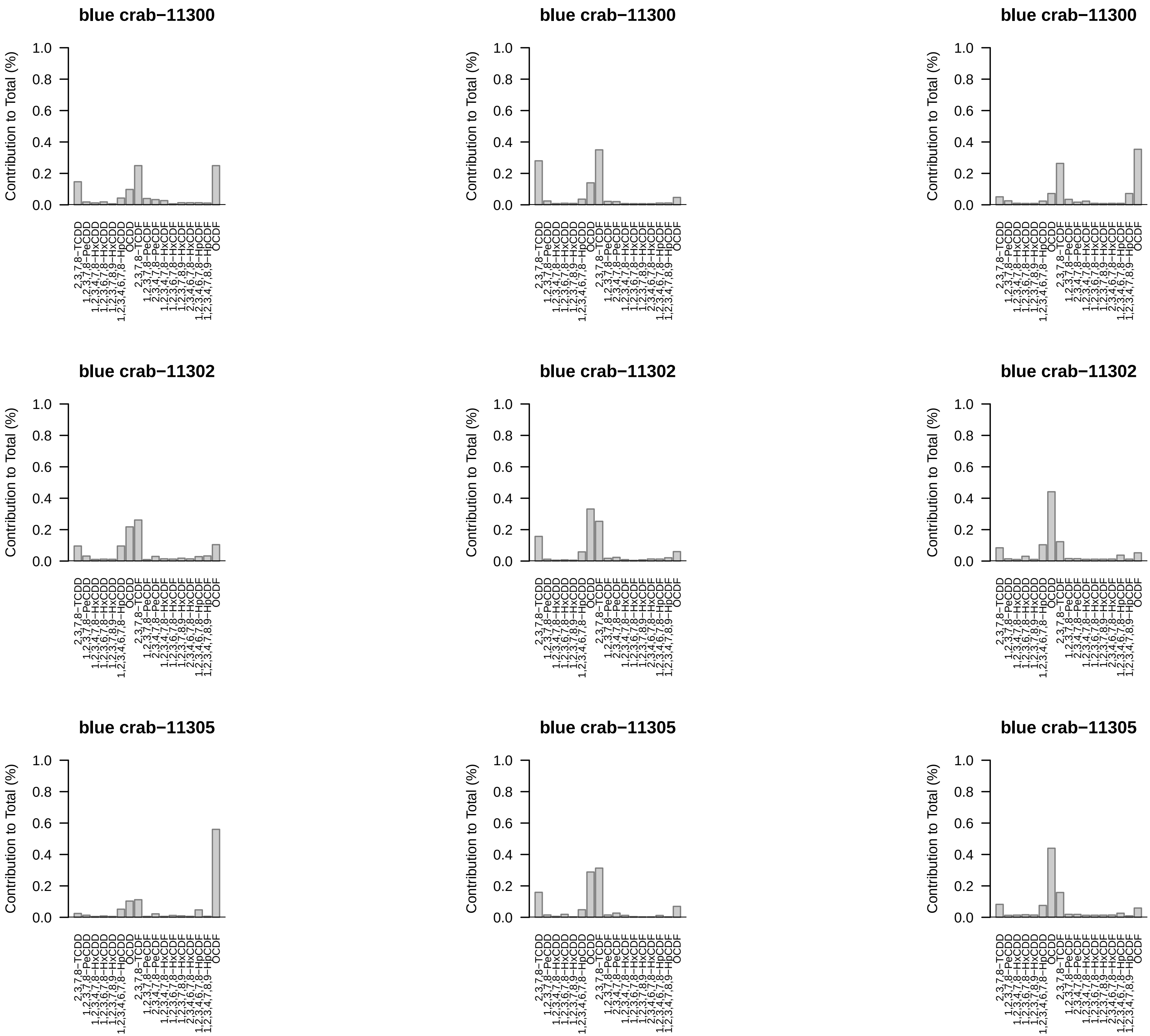

blue crab−11287
Contribution to Total (%)
0.0 0.2 0.4 0.6 0.8 1.0
2,3,7,8−TCDD
1,2,3,7,8−PeCDD
1,2,3,4,7,8−HxCDD
1,2,3,6,7,8−HxCDD
1,2,3,7,8,9−HxCDD
1,2,3,4,6,7,8−HpCDD
OCDD
2,3,7,8−TCDF
1,2,3,7,8−PeCDF
2,3,4,7,8−PeCDF
1,2,3,4,7,8−HxCDF
1,2,3,6,7,8−HxCDF
1,2,3,7,8,9−HxCDF
2,3,4,6,7,8−HxCDF
1,2,3,4,6,7,8−HpCDF
1,2,3,4,7,8,9−HpCDF
OCDF

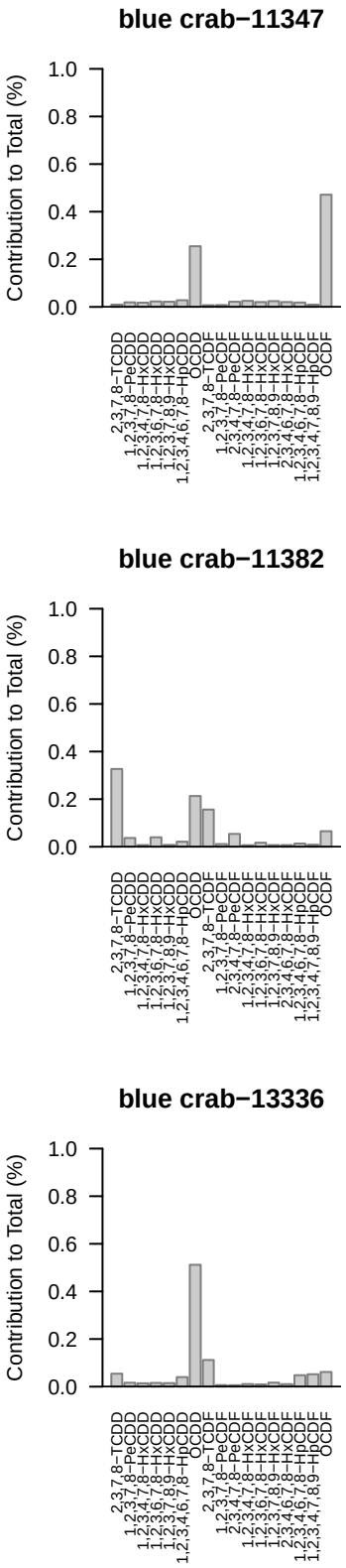

blue crab−11287
Contribution to Total (%)
0.0 0.2 0.4 0.6 0.8 1.0
2,3,7,8−TCDD
1,2,3,7,8−PeCDD
1,2,3,4,7,8−HxCDD
1,2,3,6,7,8−HxCDD
1,2,3,7,8,9−HxCDD
1,2,3,4,6,7,8−HpCDD
OCDD
2,3,7,8−TCDF
1,2,3,7,8−PeCDF
2,3,4,7,8−PeCDF
1,2,3,4,7,8−HxCDF
1,2,3,6,7,8−HxCDF
1,2,3,7,8,9−HxCDF
2,3,4,6,7,8−HxCDF
1,2,3,4,6,7,8−HpCDF
1,2,3,4,7,8,9−HpCDF
OCDF

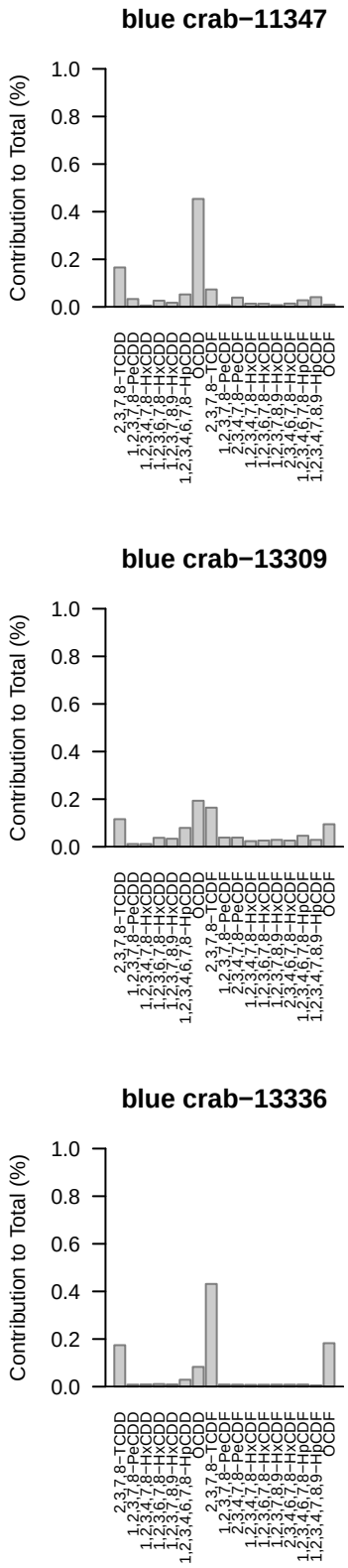

blue crab−11287
Contribution to Total (%)
0.0 0.2 0.4 0.6 0.8 1.0
2,3,7,8−TCDD
1,2,3,7,8−PeCDD
1,2,3,4,7,8−HxCDD
1,2,3,6,7,8−HxCDD
1,2,3,7,8,9−HxCDD
1,2,3,4,6,7,8−HpCDD
OCDD
2,3,7,8−TCDF
1,2,3,7,8−PeCDF
2,3,4,7,8−PeCDF
1,2,3,4,7,8−HxCDF
1,2,3,6,7,8−HxCDF
1,2,3,7,8,9−HxCDF
2,3,4,6,7,8−HxCDF
1,2,3,4,6,7,8−HpCDF
1,2,3,4,7,8,9−HpCDF
OCDF

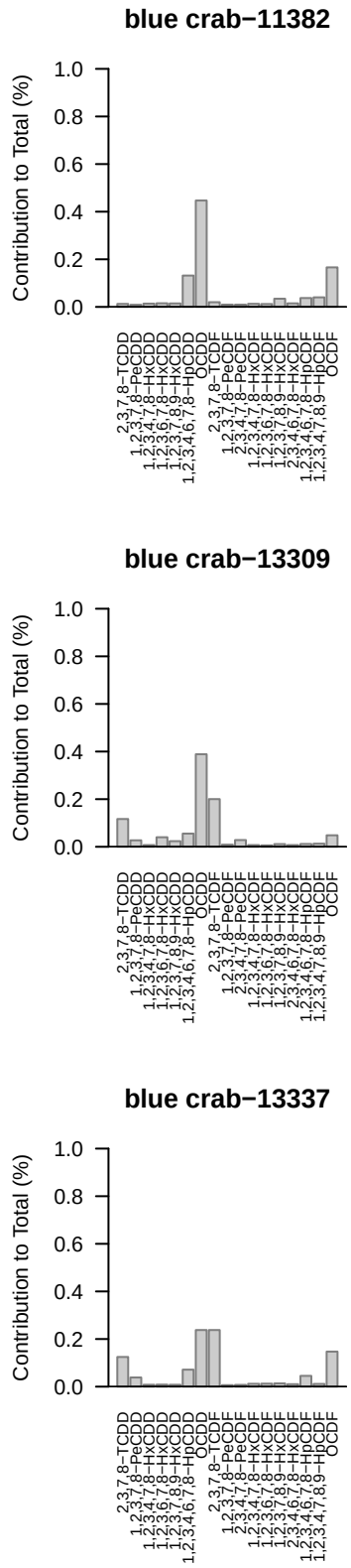

blue crab−11287
Contribution to Total (%)
0.0 0.2 0.4 0.6 0.8 1.0
2,3,7,8−TCDD
1,2,3,7,8−PeCDD
1,2,3,4,7,8−HxCDD
1,2,3,6,7,8−HxCDD
1,2,3,7,8,9−HxCDD
1,2,3,4,6,7,8−HpCDD
OCDD
2,3,7,8−TCDF
1,2,3,7,8−PeCDF
2,3,4,7,8−PeCDF
1,2,3,4,7,8−HxCDF
1,2,3,6,7,8−HxCDF
1,2,3,7,8,9−HxCDF
2,3,4,6,7,8−HxCDF
1,2,3,4,6,7,8−HpCDF
1,2,3,4,7,8,9−HpCDF
OCDF


blue crab−11287
blue crab−11292
blue crab−11292
blue crab−11292
blue crab−11292
blue crab−11298
blue crab−11298
blue crab−11298
blue crab−11298
Contribution to Total (%)
0.0
0.2
0.4
0.6
0.8
1.0
2,3,7,8−TCDD
1,2,3,7,8−PeCDD
1,2,3,4,7,8−HxCDD
1,2,3,6,7,8−HxCDD
1,2,3,7,8,9−HxCDD
1,2,3,4,6,7,8−HpCDD
OCDD
2,3,7,8−TCDF
1,2,3,7,8−PeCDF
2,3,4,7,8−PeCDF
1,2,3,4,7,8−HxCDF
1,2,3,6,7,8−HxCDF
1,2,3,7,8,9−HxCDF
2,3,4,6,7,8−HxCDF
1,2,3,4,6,7,8−HpCDF
1,2,3,4,7,8,9−HpCDF
OCDF


blue crab−11300
blue crab−11300
blue crab−11300
blue crab−11302
blue crab−11302
blue crab−11302
blue crab−11305
blue crab−11305
blue crab−11305
Contribution to Total (%)
1.0
0.8
0.6
0.4
0.2
0.0
2,3,7,8−TCDD
1,2,3,7,8−PeCDD
1,2,3,4,7,8−HxCDD
1,2,3,6,7,8−HxCDD
1,2,3,7,8,9−HxCDD
1,2,3,4,6,7,8−HpCDD
OCDD
2,3,7,8−TCDF
1,2,3,7,8−PeCDF
2,3,4,7,8−PeCDF
1,2,3,4,7,8−HxCDF
1,2,3,6,7,8−HxCDF
1,2,3,7,8,9−HxCDF
2,3,4,6,7,8−HxCDF
1,2,3,4,6,7,8−HpCDF
1,2,3,4,7,8,9−HpCDF
OCDF


blue crab−11347
Contribution to Total (%)
1.0
0.8
0.6
0.4
0.2
0.0
2,3,7,8−TCDD
1,2,3,7,8−PeCDD
1,2,3,4,7,8−HxCDD
1,2,3,6,7,8−HxCDD
1,2,3,7,8,9−HxCDD
1,2,3,4,6,7,8−HpCDD
OCDD
2,3,7,8−TCDF
1,2,3,7,8−PeCDF
2,3,4,7,8−PeCDF
1,2,3,4,7,8−HxCDF
1,2,3,6,7,8−HxCDF
1,2,3,7,8,9−HxCDF
2,3,4,6,7,8−HxCDF
1,2,3,4,6,7,8−HpCDF
1,2,3,4,7,8,9−HpCDF
OCDF


blue crab−11347
Contribution to Total (%)
1.0
0.8
0.6
0.4
0.2
0.0
2,3,7,8−TCDD
1,2,3,7,8−PeCDD
1,2,3,4,7,8−HxCDD
1,2,3,6,7,8−HxCDD
1,2,3,7,8,9−HxCDD
1,2,3,4,6,7,8−HpCDD
OCDD
2,3,7,8−TCDF
1,2,3,7,8−PeCDF
2,3,4,7,8−PeCDF
1,2,3,4,7,8−HxCDF
1,2,3,6,7,8−HxCDF
1,2,3,7,8,9−HxCDF
2,3,4,6,7,8−HxCDF
1,2,3,4,6,7,8−HpCDF
1,2,3,4,7,8,9−HpCDF
OCDF


blue crab−11382
Contribution to Total (%)
1.0
0.8
0.6
0.4
0.2
0.0
2,3,7,8−TCDD
1,2,3,7,8−PeCDD
1,2,3,4,7,8−HxCDD
1,2,3,6,7,8−HxCDD
1,2,3,7,8,9−HxCDD
1,2,3,4,6,7,8−HpCDD
OCDD
2,3,7,8−TCDF
1,2,3,7,8−PeCDF
2,3,4,7,8−PeCDF
1,2,3,4,7,8−HxCDF
1,2,3,6,7,8−HxCDF
1,2,3,7,8,9−HxCDF
2,3,4,6,7,8−HxCDF
1,2,3,4,6,7,8−HpCDF
1,2,3,4,7,8,9−HpCDF
OCDF

blue crab−11382
Contribution to Total (%)
1.0
0.8
0.6
0.4
0.2
0.0
2,3,7,8−TCDD
1,2,3,7,8−PeCDD
1,2,3,4,7,8−HxCDD
1,2,3,6,7,8−HxCDD
1,2,3,7,8,9−HxCDD
1,2,3,4,6,7,8−HpCDD
OCDD
2,3,7,8−TCDF
1,2,3,7,8−PeCDF
2,3,4,7,8−PeCDF
1,2,3,4,7,8−HxCDF
1,2,3,6,7,8−HxCDF
1,2,3,7,8,9−HxCDF
2,3,4,6,7,8−HxCDF
1,2,3,4,6,7,8−HpCDF
1,2,3,4,7,8,9−HpCDF
OCDF

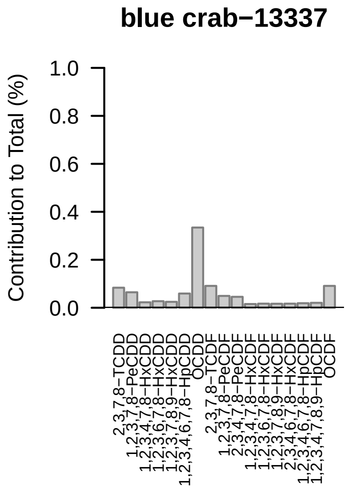
blue crab−13309
Contribution to Total (%)
1.0
0.8
0.6
0.4
0.2
0.0
2,3,7,8−TCDD
1,2,3,7,8−PeCDD
1,2,3,4,7,8−HxCDD
1,2,3,6,7,8−HxCDD
1,2,3,7,8,9−HxCDD
1,2,3,4,6,7,8−HpCDD
OCDD
2,3,7,8−TCDF
1,2,3,7,8−PeCDF
2,3,4,7,8−PeCDF
1,2,3,4,7,8−HxCDF
1,2,3,6,7,8−HxCDF
1,2,3,7,8,9−HxCDF
2,3,4,6,7,8−HxCDF
1,2,3,4,6,7,8−HpCDF
1,2,3,4,7,8,9−HpCDF
OCDF

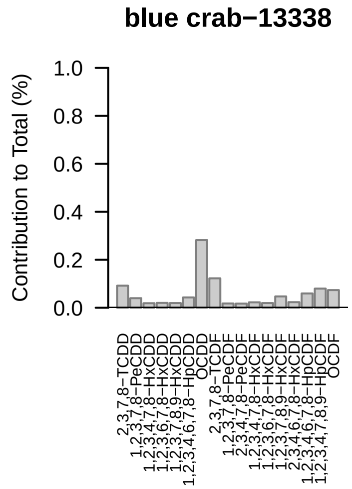
blue crab−13309
Contribution to Total (%)
1.0
0.8
0.6
0.4
0.2
0.0
2,3,7,8−TCDD
1,2,3,7,8−PeCDD
1,2,3,4,7,8−HxCDD
1,2,3,6,7,8−HxCDD
1,2,3,7,8,9−HxCDD
1,2,3,4,6,7,8−HpCDD
OCDD
2,3,7,8−TCDF
1,2,3,7,8−PeCDF
2,3,4,7,8−PeCDF
1,2,3,4,7,8−HxCDF
1,2,3,6,7,8−HxCDF
1,2,3,7,8,9−HxCDF
2,3,4,6,7,8−HxCDF
1,2,3,4,6,7,8−HpCDF
1,2,3,4,7,8,9−HpCDF
OCDF

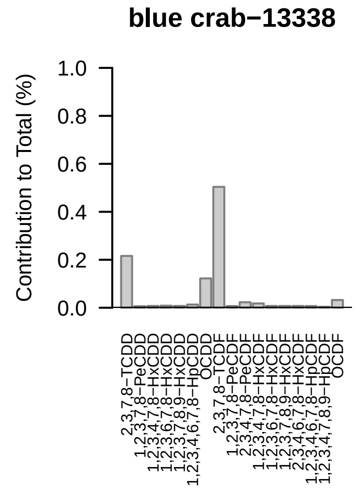
blue crab−13336
Contribution to Total (%)
1.0
0.8
0.6
0.4
0.2
0.0
2,3,7,8−TCDD
1,2,3,7,8−PeCDD
1,2,3,4,7,8−HxCDD
1,2,3,6,7,8−HxCDD
1,2,3,7,8,9−HxCDD
1,2,3,4,6,7,8−HpCDD
OCDD
2,3,7,8−TCDF
1,2,3,7,8−PeCDF
2,3,4,7,8−PeCDF
1,2,3,4,7,8−HxCDF
1,2,3,6,7,8−HxCDF
1,2,3,7,8,9−HxCDF
2,3,4,6,7,8−HxCDF
1,2,3,4,6,7,8−HpCDF
1,2,3,4,7,8,9−HpCDF
OCDF

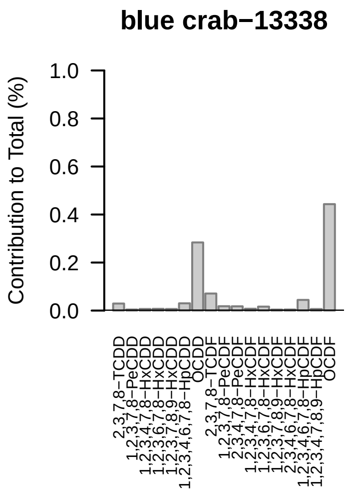
blue crab−13336
Contribution to Total (%)
1.0
0.8
0.6
0.4
0.2
0.0
2,3,7,8−TCDD
1,2,3,7,8−PeCDD
1,2,3,4,7,8−HxCDD
1,2,3,6,7,8−HxCDD
1,2,3,7,8,9−HxCDD
1,2,3,4,6,7,8−HpCDD
OCDD
2,3,7,8−TCDF
1,2,3,7,8−PeCDF
2,3,4,7,8−PeCDF
1,2,3,4,7,8−HxCDF
1,2,3,6,7,8−HxCDF
1,2,3,7,8,9−HxCDF
2,3,4,6,7,8−HxCDF
1,2,3,4,6,7,8−HpCDF
1,2,3,4,7,8,9−HpCDF
OCDF

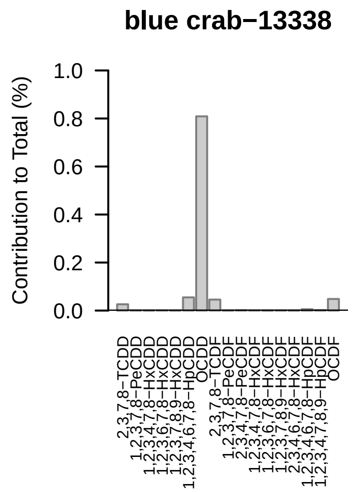
blue crab−13337
Contribution to Total (%)
1.0
0.8
0.6
0.4
0.2
0.0
2,3,7,8−TCDD
1,2,3,7,8−PeCDD
1,2,3,4,7,8−HxCDD
1,2,3,6,7,8−HxCDD
1,2,3,7,8,9−HxCDD
1,2,3,4,6,7,8−HpCDD
OCDD
2,3,7,8−TCDF
1,2,3,7,8−PeCDF
2,3,4,7,8−PeCDF
1,2,3,4,7,8−HxCDF
1,2,3,6,7,8−HxCDF
1,2,3,7,8,9−HxCDF
2,3,4,6,7,8−HxCDF
1,2,3,4,6,7,8−HpCDF
1,2,3,4,7,8,9−HpCDF
OCDF

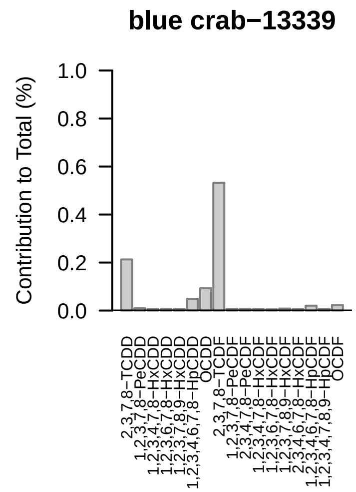

blue crab−13337
Contribution to Total (%)
1.0
0.8
0.6
0.4
0.2
0.0
2,3,7,8−TCDD
1,2,3,7,8−PeCDD
1,2,3,4,7,8−HxCDD
1,2,3,6,7,8−HxCDD
1,2,3,7,8,9−HxCDD
1,2,3,4,6,7,8−HpCDD
OCDD
2,3,7,8−TCDF
1,2,3,7,8−PeCDF
2,3,4,7,8−PeCDF
1,2,3,4,7,8−HxCDF
1,2,3,6,7,8−HxCDF
1,2,3,7,8,9−HxCDF
2,3,4,6,7,8−HxCDF
1,2,3,4,6,7,8−HpCDF
1,2,3,4,7,8,9−HpCDF
OCDF

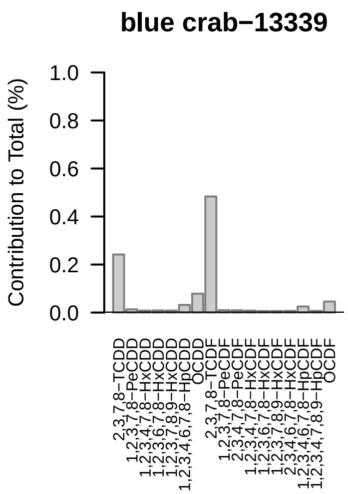

blue crab−13338
Contribution to Total (%)
1.0
0.8
0.6
0.4
0.2
0.0
2,3,7,8−TCDD
1,2,3,7,8−PeCDD
1,2,3,4,7,8−HxCDD
1,2,3,6,7,8−HxCDD
1,2,3,7,8,9−HxCDD
1,2,3,4,6,7,8−HpCDD
OCDD
2,3,7,8−TCDF
1,2,3,7,8−PeCDF
2,3,4,7,8−PeCDF
1,2,3,4,7,8−HxCDF
1,2,3,6,7,8−HxCDF
1,2,3,7,8,9−HxCDF
2,3,4,6,7,8−HxCDF
1,2,3,4,6,7,8−HpCDF
1,2,3,4,7,8,9−HpCDF
OCDF

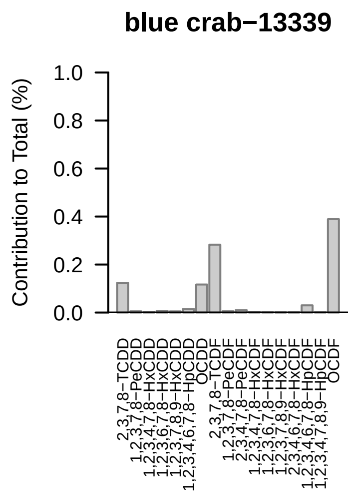

blue crab−13338
Contribution to Total (%)
1.0
0.8
0.6
0.4
0.2
0.0
2,3,7,8−TCDD
1,2,3,7,8−PeCDD
1,2,3,4,7,8−HxCDD
1,2,3,6,7,8−HxCDD
1,2,3,7,8,9−HxCDD
1,2,3,4,6,7,8−HpCDD
OCDD
2,3,7,8−TCDF
1,2,3,7,8−PeCDF
2,3,4,7,8−PeCDF
1,2,3,4,7,8−HxCDF
1,2,3,6,7,8−HxCDF
1,2,3,7,8,9−HxCDF
2,3,4,6,7,8−HxCDF
1,2,3,4,6,7,8−HpCDF
1,2,3,4,7,8,9−HpCDF
OCDF

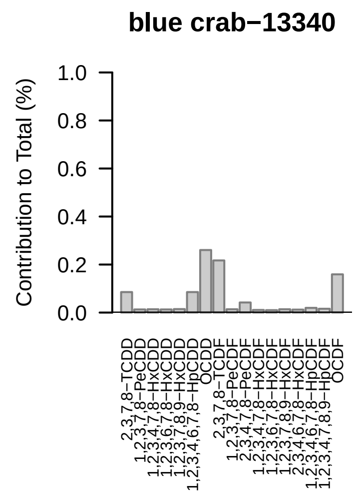

blue crab−13338
Contribution to Total (%)
1.0
0.8
0.6
0.4
0.2
0.0
2,3,7,8−TCDD
1,2,3,7,8−PeCDD
1,2,3,4,7,8−HxCDD
1,2,3,6,7,8−HxCDD
1,2,3,7,8,9−HxCDD
1,2,3,4,6,7,8−HpCDD
OCDD
2,3,7,8−TCDF
1,2,3,7,8−PeCDF
2,3,4,7,8−PeCDF
1,2,3,4,7,8−HxCDF
1,2,3,6,7,8−HxCDF
1,2,3,7,8,9−HxCDF
2,3,4,6,7,8−HxCDF
1,2,3,4,6,7,8−HpCDF
1,2,3,4,7,8,9−HpCDF
OCDF

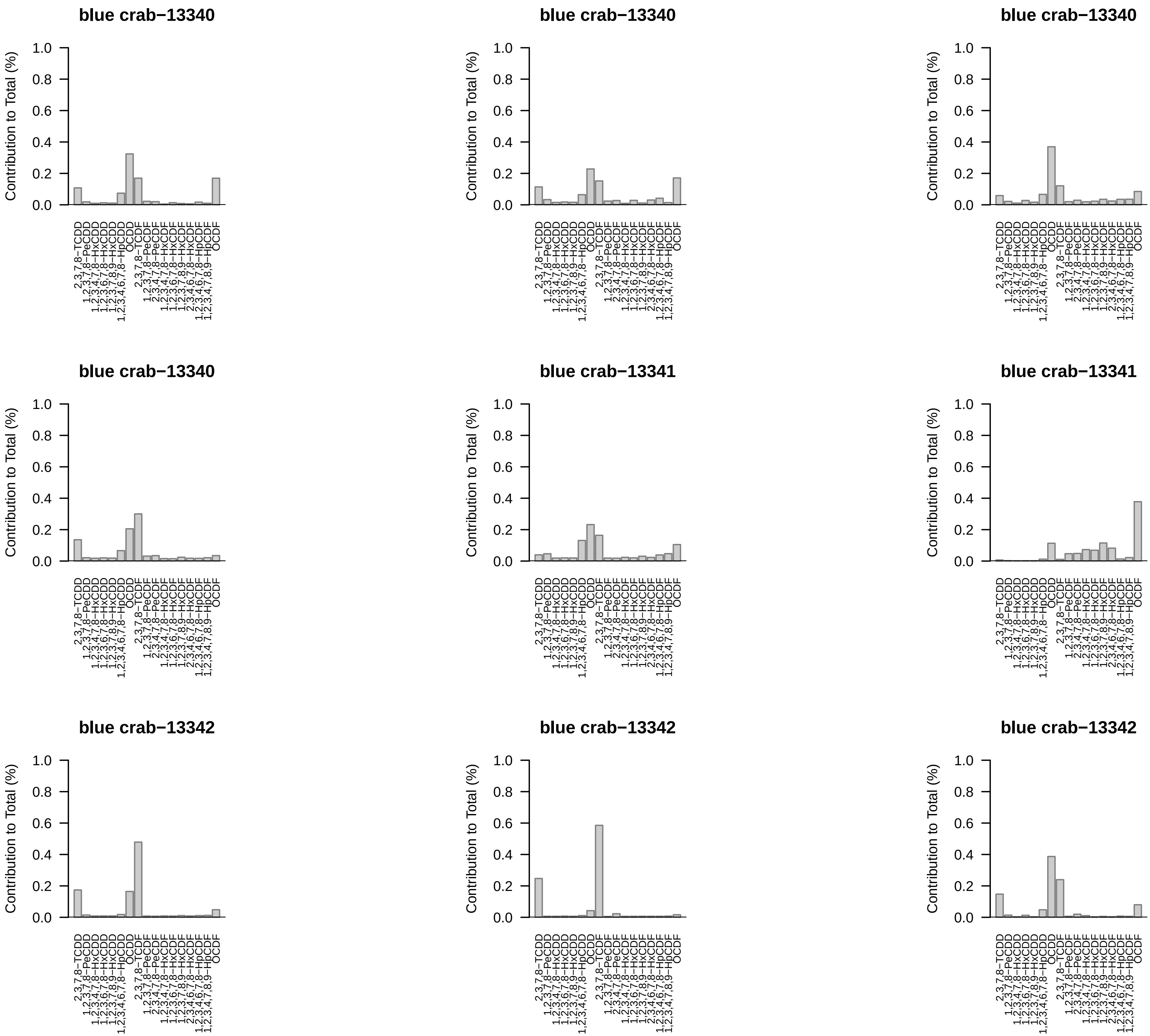

blue crab−13338
Contribution to Total (%)
1.0
0.8
0.6
0.4
0.2
0.0
2,3,7,8−TCDD
1,2,3,7,8−PeCDD
1,2,3,4,7,8−HxCDD
1,2,3,6,7,8−HxCDD
1,2,3,7,8,9−HxCDD
1,2,3,4,6,7,8−HpCDD
OCDD
2,3,7,8−TCDF
1,2,3,7,8−PeCDF
2,3,4,7,8−PeCDF
1,2,3,4,7,8−HxCDF
1,2,3,6,7,8−HxCDF
1,2,3,7,8,9−HxCDF
2,3,4,6,7,8−HxCDF
1,2,3,4,6,7,8−HpCDF
1,2,3,4,7,8,9−HpCDF
OCDF

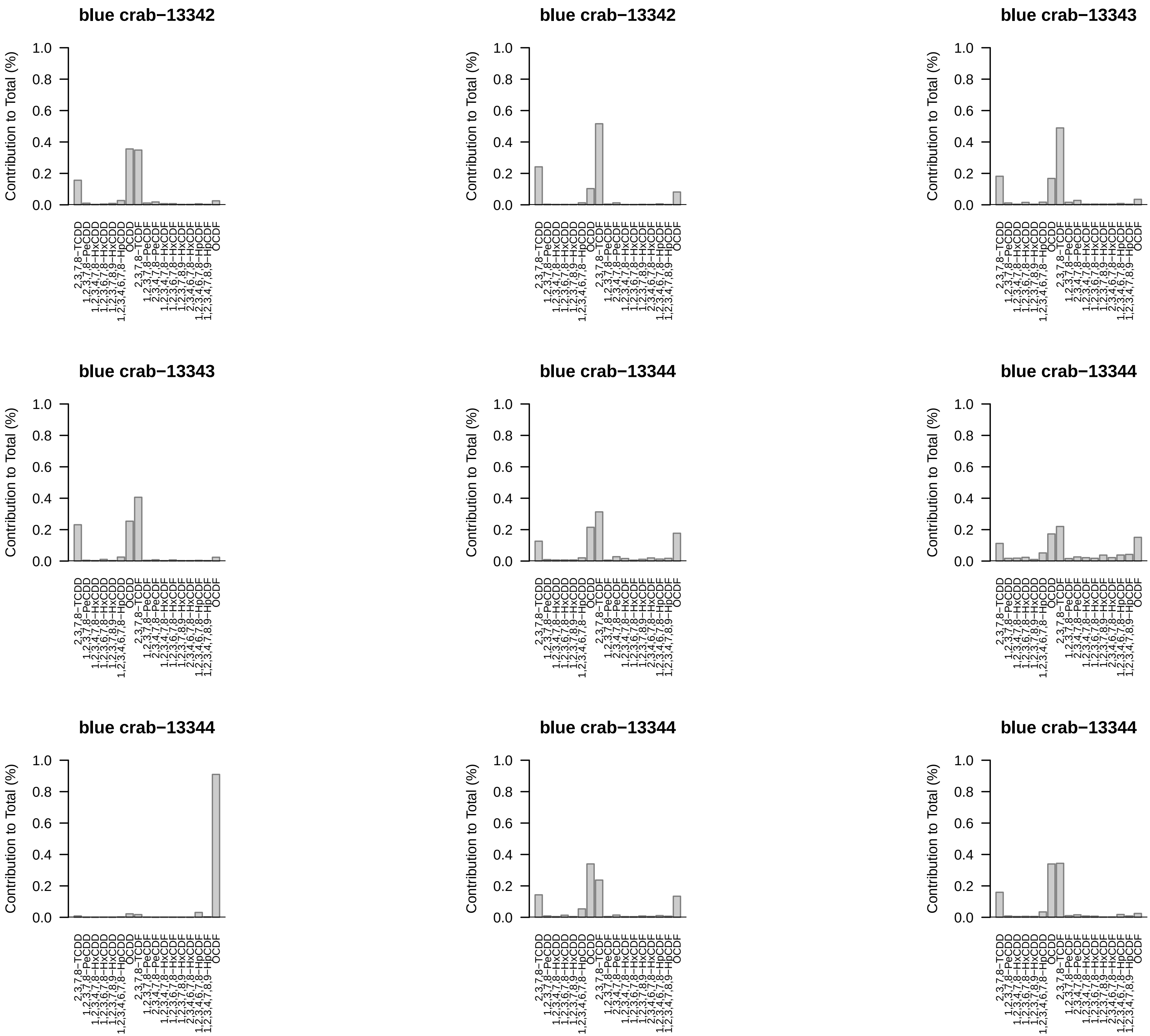

blue crab−13339
Contribution to Total (%)
1.0
0.8
0.6
0.4
0.2
0.0
2,3,7,8−TCDD
1,2,3,7,8−PeCDD
1,2,3,4,7,8−HxCDD
1,2,3,6,7,8−HxCDD
1,2,3,7,8,9−HxCDD
1,2,3,4,6,7,8−HpCDD
OCDD
2,3,7,8−TCDF
1,2,3,7,8−PeCDF
2,3,4,7,8−PeCDF
1,2,3,4,7,8−HxCDF
1,2,3,6,7,8−HxCDF
1,2,3,7,8,9−HxCDF
2,3,4,6,7,8−HxCDF
1,2,3,4,6,7,8−HpCDF
1,2,3,4,7,8,9−HpCDF
OCDF

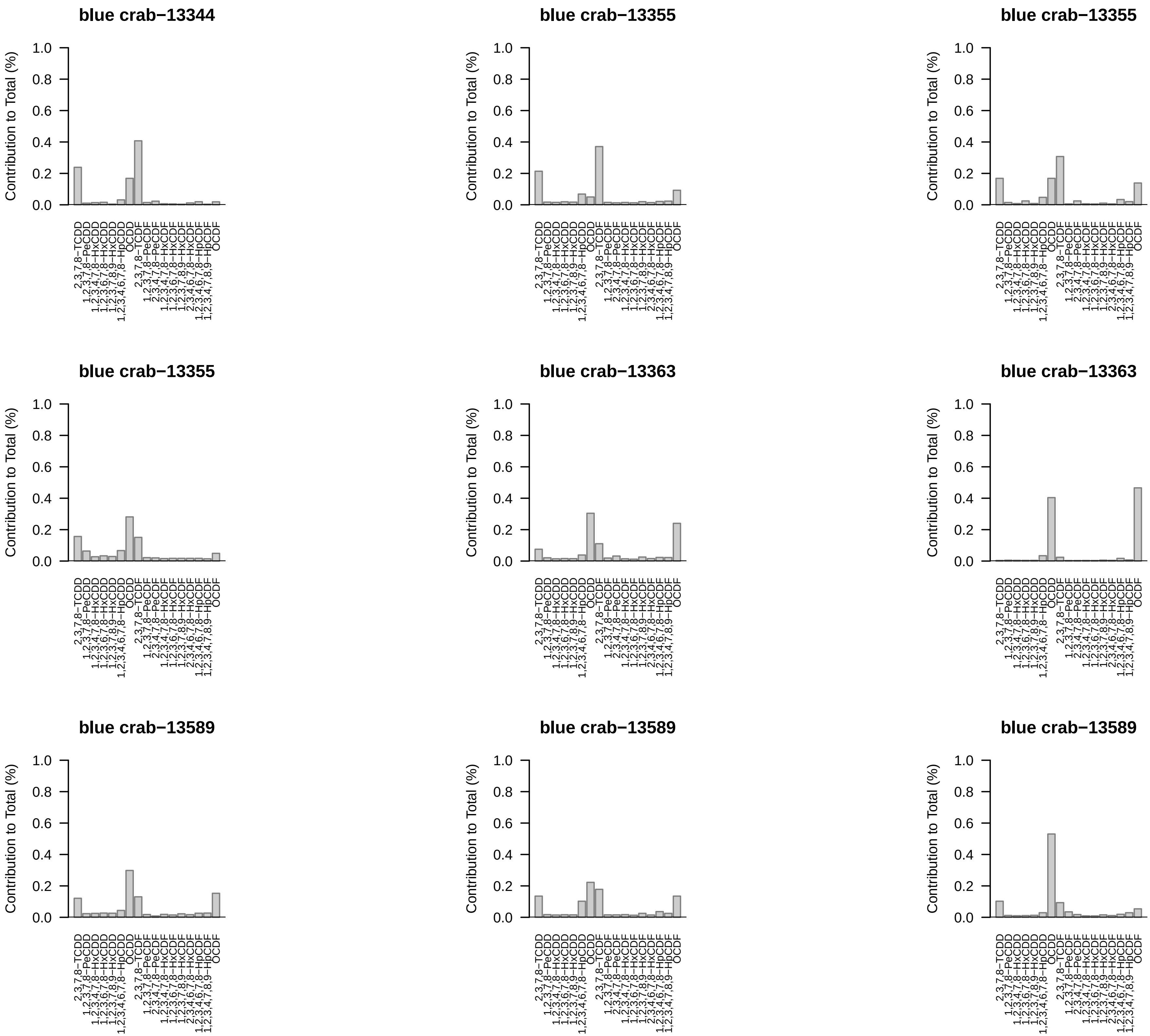

blue crab−13339
Contribution to Total (%)
1.0
0.8
0.6
0.4
0.2
0.0
2,3,7,8−TCDD
1,2,3,7,8−PeCDD
1,2,3,4,7,8−HxCDD
1,2,3,6,7,8−HxCDD
1,2,3,7,8,9−HxCDD
1,2,3,4,6,7,8−HpCDD
OCDD
2,3,7,8−TCDF
1,2,3,7,8−PeCDF
2,3,4,7,8−PeCDF
1,2,3,4,7,8−HxCDF
1,2,3,6,7,8−HxCDF
1,2,3,7,8,9−HxCDF
2,3,4,6,7,8−HxCDF
1,2,3,4,6,7,8−HpCDF
1,2,3,4,7,8,9−HpCDF
OCDF

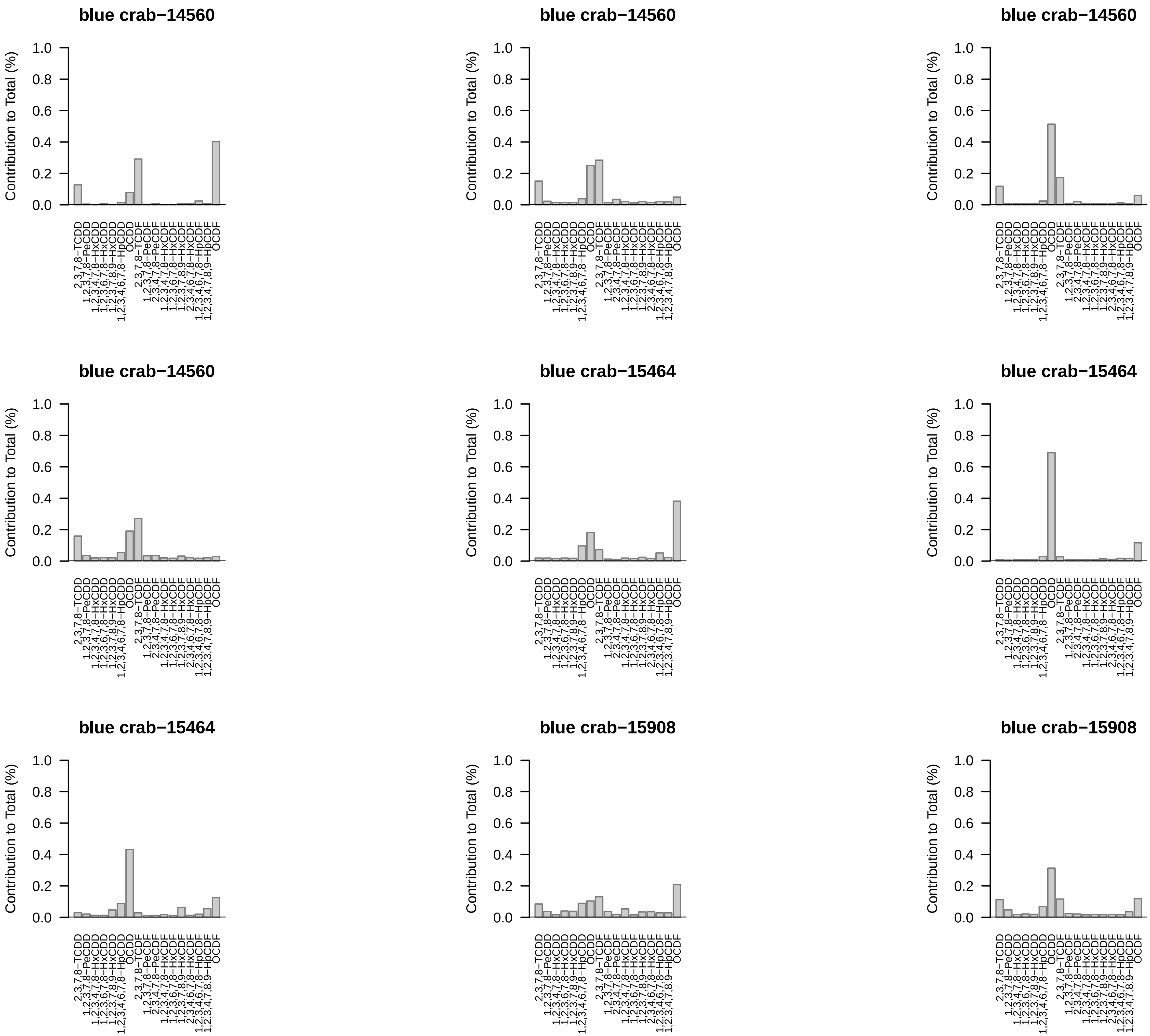

blue crab−13339
Contribution to Total (%)
1.0
0.8
0.6
0.4
0.2
0.0
2,3,7,8−TCDD
1,2,3,7,8−PeCDD
1,2,3,4,7,8−HxCDD
1,2,3,6,7,8−HxCDD
1,2,3,7,8,9−HxCDD
1,2,3,4,6,7,8−HpCDD
OCDD
2,3,7,8−TCDF
1,2,3,7,8−PeCDF
2,3,4,7,8−PeCDF
1,2,3,4,7,8−HxCDF
1,2,3,6,7,8−HxCDF
1,2,3,7,8,9−HxCDF
2,3,4,6,7,8−HxCDF
1,2,3,4,6,7,8−HpCDF
1,2,3,4,7,8,9−HpCDF
OCDF

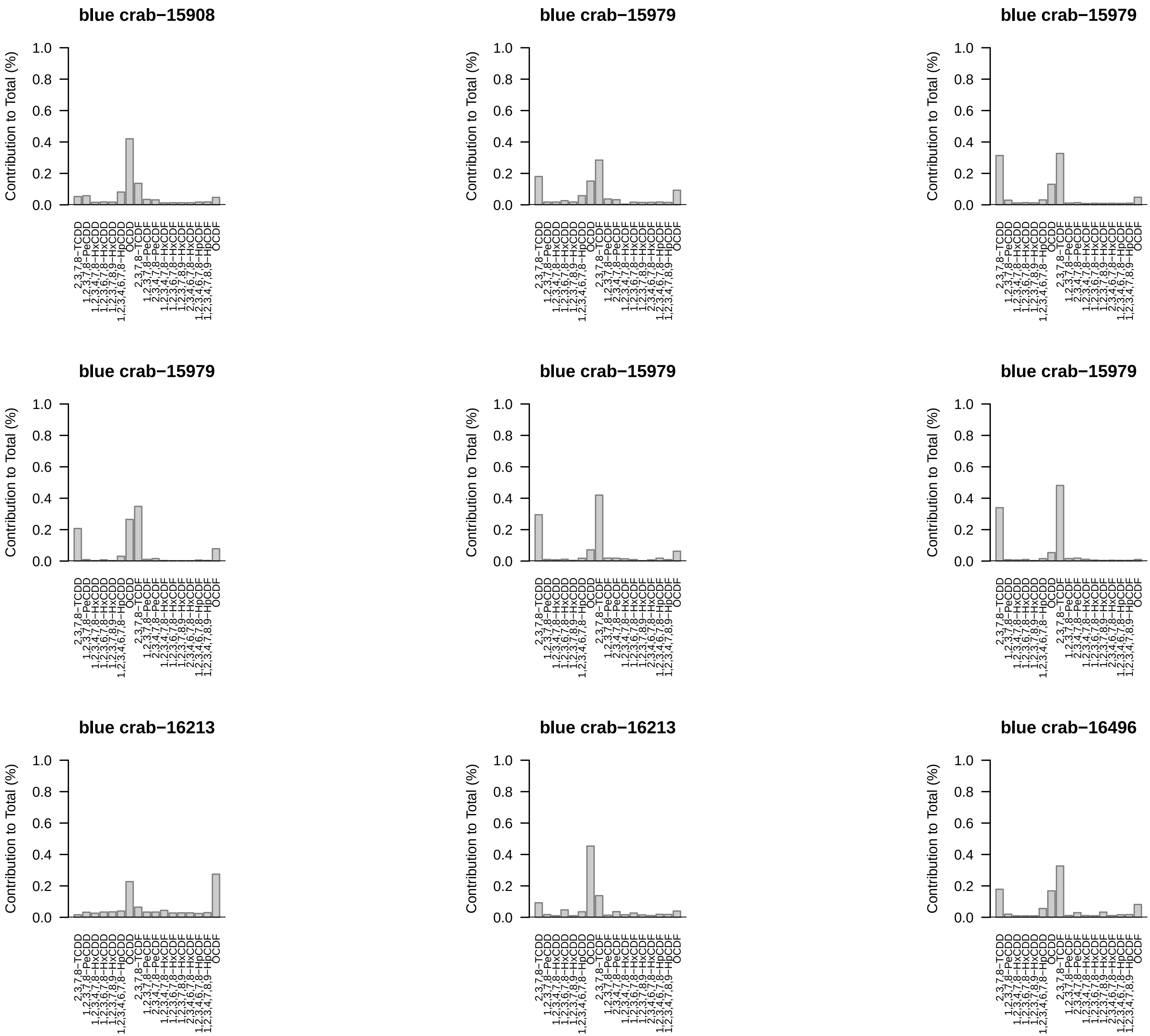

blue crab−13340
Contribution to Total (%)
1.0
0.8
0.6
0.4
0.2
0.0
2,3,7,8−TCDD
1,2,3,7,8−PeCDD
1,2,3,4,7,8−HxCDD
1,2,3,6,7,8−HxCDD
1,2,3,7,8,9−HxCDD
1,2,3,4,6,7,8−HpCDD
OCDD
2,3,7,8−TCDF
1,2,3,7,8−PeCDF
2,3,4,7,8−PeCDF
1,2,3,4,7,8−HxCDF
1,2,3,6,7,8−HxCDF
1,2,3,7,8,9−HxCDF
2,3,4,6,7,8−HxCDF
1,2,3,4,6,7,8−HpCDF
1,2,3,4,7,8,9−HpCDF
OCDF

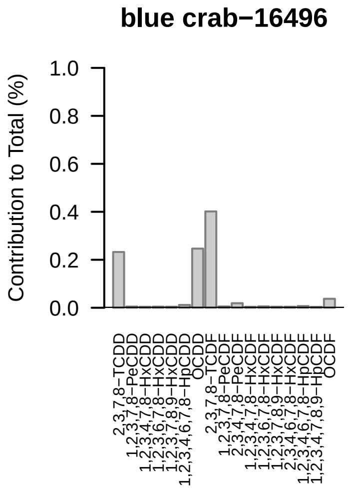

blue crab−13340
blue crab−13340
blue crab−13340
blue crab−13340
blue crab−13341
blue crab−13341
blue crab−13342
blue crab−13342
blue crab−13342
Contribution to Total (%)
0.0
0.2
0.4
0.6
0.8
1.0
2,3,7,8−TCDD
1,2,3,7,8−PeCDD
1,2,3,4,7,8−HxCDD
1,2,3,6,7,8−HxCDD
1,2,3,7,8,9−HxCDD
1,2,3,4,6,7,8−HpCDD
OCDD
2,3,7,8−TCDF
1,2,3,7,8−PeCDF
2,3,4,7,8−PeCDF
1,2,3,4,7,8−HxCDF
1,2,3,6,7,8−HxCDF
1,2,3,7,8,9−HxCDF
2,3,4,6,7,8−HxCDF
1,2,3,4,6,7,8−HpCDF
1,2,3,4,7,8,9−HpCDF
OCDF

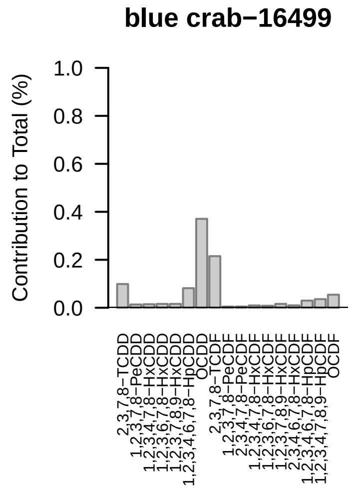

blue crab−13342
blue crab−13342
blue crab−13343
blue crab−13343
blue crab−13344
blue crab−13344
blue crab−13344
blue crab−13344
blue crab−13344
Contribution to Total (%)
0.0
0.2
0.4
0.6
0.8
1.0
2,3,7,8−TCDD
1,2,3,7,8−PeCDD
1,2,3,4,7,8−HxCDD
1,2,3,6,7,8−HxCDD
1,2,3,7,8,9−HxCDD
1,2,3,4,6,7,8−HpCDD
OCDD
2,3,7,8−TCDF
1,2,3,7,8−PeCDF
2,3,4,7,8−PeCDF
1,2,3,4,7,8−HxCDF
1,2,3,6,7,8−HxCDF
1,2,3,7,8,9−HxCDF
2,3,4,6,7,8−HxCDF
1,2,3,4,6,7,8−HpCDF
1,2,3,4,7,8,9−HpCDF
OCDF

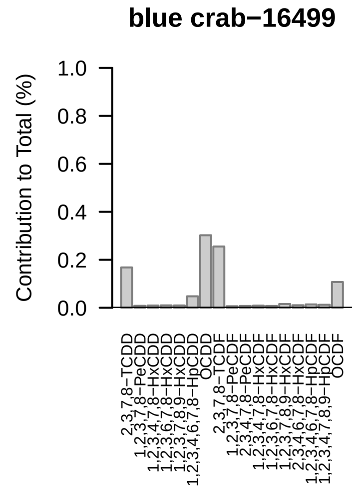

blue crab−13344
blue crab−13355
blue crab−13355
blue crab−13355
blue crab−13363
blue crab−13363
blue crab−13589
blue crab−13589
blue crab−13589
Contribution to Total (%)
0.0
0.2
0.4
0.6
0.8
1.0
2,3,7,8−TCDD
1,2,3,7,8−PeCDD
1,2,3,4,7,8−HxCDD
1,2,3,6,7,8−HxCDD
1,2,3,7,8,9−HxCDD
1,2,3,4,6,7,8−HpCDD
OCDD
2,3,7,8−TCDF
1,2,3,7,8−PeCDF
2,3,4,7,8−PeCDF
1,2,3,4,7,8−HxCDF
1,2,3,6,7,8−HxCDF
1,2,3,7,8,9−HxCDF
2,3,4,6,7,8−HxCDF
1,2,3,4,6,7,8−HpCDF
1,2,3,4,7,8,9−HpCDF
OCDF

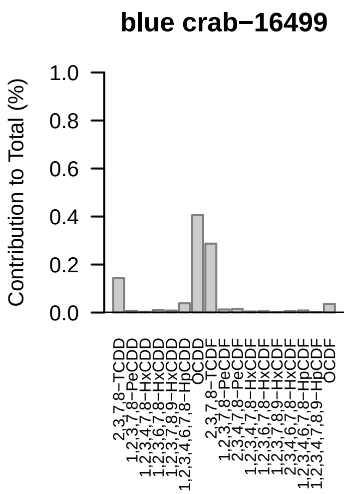

blue crab−14560
blue crab−14560
blue crab−14560
blue crab−14560
blue crab−15464
blue crab−15464
blue crab−15464
blue crab−15908
blue crab−15908
Contribution to Total (%)
0.0
0.2
0.4
0.6
0.8
1.0
2,3,7,8−TCDD
1,2,3,7,8−PeCDD
1,2,3,4,7,8−HxCDD
1,2,3,6,7,8−HxCDD
1,2,3,7,8,9−HxCDD
1,2,3,4,6,7,8−HpCDD
OCDD
2,3,7,8−TCDF
1,2,3,7,8−PeCDF
2,3,4,7,8−PeCDF
1,2,3,4,7,8−HxCDF
1,2,3,6,7,8−HxCDF
1,2,3,7,8,9−HxCDF
2,3,4,6,7,8−HxCDF
1,2,3,4,6,7,8−HpCDF
1,2,3,4,7,8,9−HpCDF
OCDF

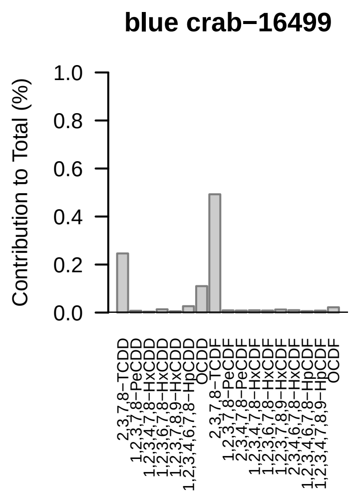

blue crab−15908
blue crab−15979
blue crab−15979
blue crab−15979
blue crab−15979
blue crab−15979
blue crab−16213
blue crab−16213
blue crab−16496
Contribution to Total (%)
0.0
0.2
0.4
0.6
0.8
1.0
2,3,7,8−TCDD
1,2,3,7,8−PeCDD
1,2,3,4,7,8−HxCDD
1,2,3,6,7,8−HxCDD
1,2,3,7,8,9−HxCDD
1,2,3,4,6,7,8−HpCDD
OCDD
2,3,7,8−TCDF
1,2,3,7,8−PeCDF
2,3,4,7,8−PeCDF
1,2,3,4,7,8−HxCDF
1,2,3,6,7,8−HxCDF
1,2,3,7,8,9−HxCDF
2,3,4,6,7,8−HxCDF
1,2,3,4,6,7,8−HpCDF
1,2,3,4,7,8,9−HpCDF
OCDF

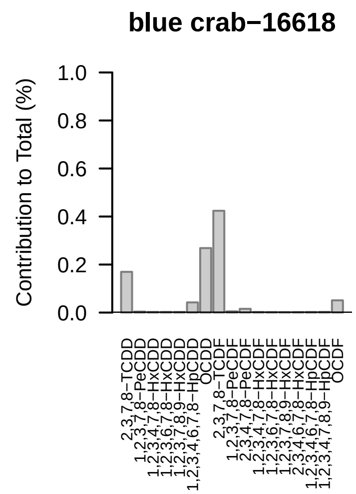

blue crab−16496
Contribution to Total (%)
0.0
0.2
0.4
0.6
0.8
1.0
2,3,7,8−TCDD
1,2,3,7,8−PeCDD
1,2,3,4,7,8−HxCDD
1,2,3,6,7,8−HxCDD
1,2,3,7,8,9−HxCDD
1,2,3,4,6,7,8−HpCDD
OCDD
2,3,7,8−TCDF
1,2,3,7,8−PeCDF
2,3,4,7,8−PeCDF
1,2,3,4,7,8−HxCDF
1,2,3,6,7,8−HxCDF
1,2,3,7,8,9−HxCDF
2,3,4,6,7,8−HxCDF
1,2,3,4,6,7,8−HpCDF
1,2,3,4,7,8,9−HpCDF
OCDF

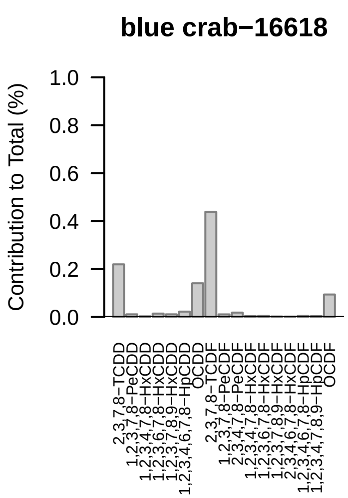

blue crab−16499
Contribution to Total (%)
0.0
0.2
0.4
0.6
0.8
1.0
2,3,7,8−TCDD
1,2,3,7,8−PeCDD
1,2,3,4,7,8−HxCDD
1,2,3,6,7,8−HxCDD
1,2,3,7,8,9−HxCDD
1,2,3,4,6,7,8−HpCDD
OCDD
2,3,7,8−TCDF
1,2,3,7,8−PeCDF
2,3,4,7,8−PeCDF
1,2,3,4,7,8−HxCDF
1,2,3,6,7,8−HxCDF
1,2,3,7,8,9−HxCDF
2,3,4,6,7,8−HxCDF
1,2,3,4,6,7,8−HpCDF
1,2,3,4,7,8,9−HpCDF
OCDF

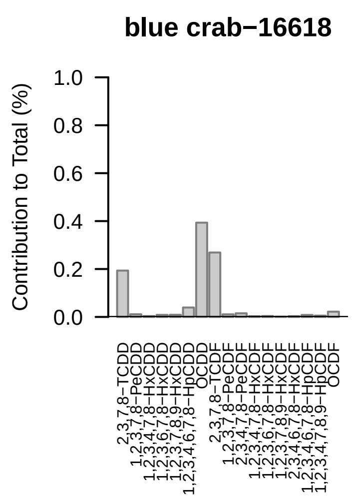

blue crab−16499
Contribution to Total (%)
0.0
0.2
0.4
0.6
0.8
1.0
2,3,7,8−TCDD
1,2,3,7,8−PeCDD
1,2,3,4,7,8−HxCDD
1,2,3,6,7,8−HxCDD
1,2,3,7,8,9−HxCDD
1,2,3,4,6,7,8−HpCDD
OCDD
2,3,7,8−TCDF
1,2,3,7,8−PeCDF
2,3,4,7,8−PeCDF
1,2,3,4,7,8−HxCDF
1,2,3,6,7,8−HxCDF
1,2,3,7,8,9−HxCDF
2,3,4,6,7,8−HxCDF
1,2,3,4,6,7,8−HpCDF
1,2,3,4,7,8,9−HpCDF
OCDF

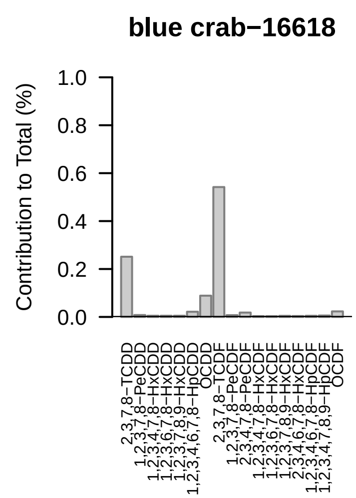

blue crab−16499
Contribution to Total (%)
0.0
0.2
0.4
0.6
0.8
1.0
2,3,7,8−TCDD
1,2,3,7,8−PeCDD
1,2,3,4,7,8−HxCDD
1,2,3,6,7,8−HxCDD
1,2,3,7,8,9−HxCDD
1,2,3,4,6,7,8−HpCDD
OCDD
2,3,7,8−TCDF
1,2,3,7,8−PeCDF
2,3,4,7,8−PeCDF
1,2,3,4,7,8−HxCDF
1,2,3,6,7,8−HxCDF
1,2,3,7,8,9−HxCDF
2,3,4,6,7,8−HxCDF
1,2,3,4,6,7,8−HpCDF
1,2,3,4,7,8,9−HpCDF
OCDF

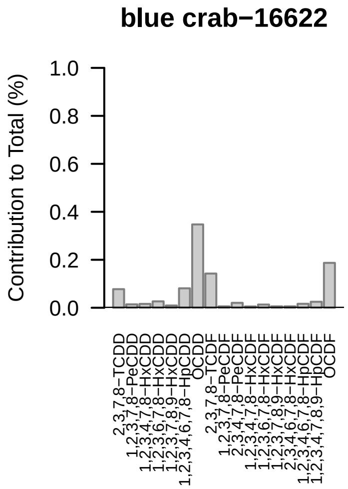

blue crab−16499
Contribution to Total (%)
0.0
0.2
0.4
0.6
0.8
1.0
2,3,7,8−TCDD
1,2,3,7,8−PeCDD
1,2,3,4,7,8−HxCDD
1,2,3,6,7,8−HxCDD
1,2,3,7,8,9−HxCDD
1,2,3,4,6,7,8−HpCDD
OCDD
2,3,7,8−TCDF
1,2,3,7,8−PeCDF
2,3,4,7,8−PeCDF
1,2,3,4,7,8−HxCDF
1,2,3,6,7,8−HxCDF
1,2,3,7,8,9−HxCDF
2,3,4,6,7,8−HxCDF
1,2,3,4,6,7,8−HpCDF
1,2,3,4,7,8,9−HpCDF
OCDF

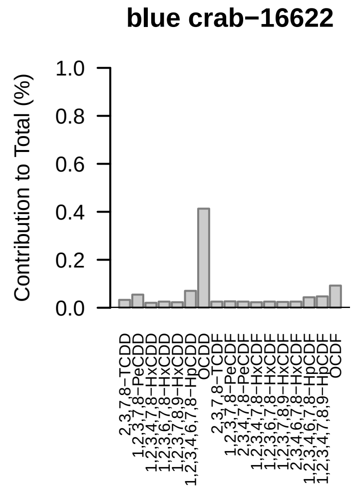

blue crab−16618
Contribution to Total (%)
0.0
0.2
0.4
0.6
0.8
1.0
2,3,7,8−TCDD
1,2,3,7,8−PeCDD
1,2,3,4,7,8−HxCDD
1,2,3,6,7,8−HxCDD
1,2,3,7,8,9−HxCDD
1,2,3,4,6,7,8−HpCDD
OCDD
2,3,7,8−TCDF
1,2,3,7,8−PeCDF
2,3,4,7,8−PeCDF
1,2,3,4,7,8−HxCDF
1,2,3,6,7,8−HxCDF
1,2,3,7,8,9−HxCDF
2,3,4,6,7,8−HxCDF
1,2,3,4,6,7,8−HpCDF
1,2,3,4,7,8,9−HpCDF
OCDF

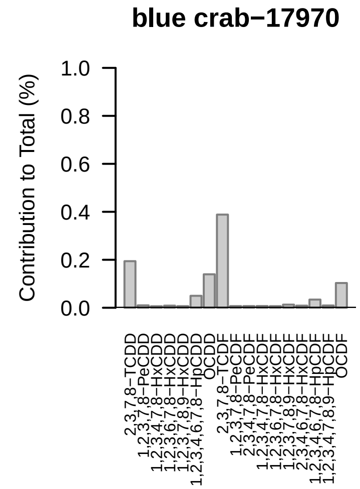

blue crab−16618
Contribution to Total (%)
0.0
0.2
0.4
0.6
0.8
1.0
2,3,7,8−TCDD
1,2,3,7,8−PeCDD
1,2,3,4,7,8−HxCDD
1,2,3,6,7,8−HxCDD
1,2,3,7,8,9−HxCDD
1,2,3,4,6,7,8−HpCDD
OCDD
2,3,7,8−TCDF
1,2,3,7,8−PeCDF
2,3,4,7,8−PeCDF
1,2,3,4,7,8−HxCDF
1,2,3,6,7,8−HxCDF
1,2,3,7,8,9−HxCDF
2,3,4,6,7,8−HxCDF
1,2,3,4,6,7,8−HpCDF
1,2,3,4,7,8,9−HpCDF
OCDF

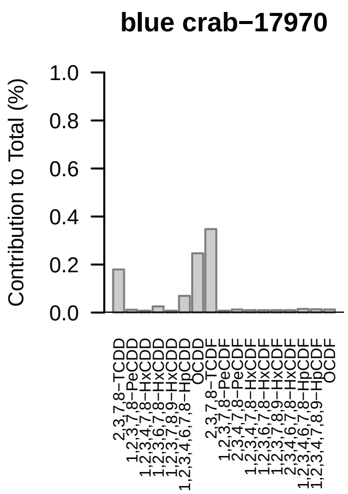

blue crab−16618
Contribution to Total (%)
0.0
0.2
0.4
0.6
0.8
1.0
2,3,7,8−TCDD
1,2,3,7,8−PeCDD
1,2,3,4,7,8−HxCDD
1,2,3,6,7,8−HxCDD
1,2,3,7,8,9−HxCDD
1,2,3,4,6,7,8−HpCDD
OCDD
2,3,7,8−TCDF
1,2,3,7,8−PeCDF
2,3,4,7,8−PeCDF
1,2,3,4,7,8−HxCDF
1,2,3,6,7,8−HxCDF
1,2,3,7,8,9−HxCDF
2,3,4,6,7,8−HxCDF
1,2,3,4,6,7,8−HpCDF
1,2,3,4,7,8,9−HpCDF
OCDF

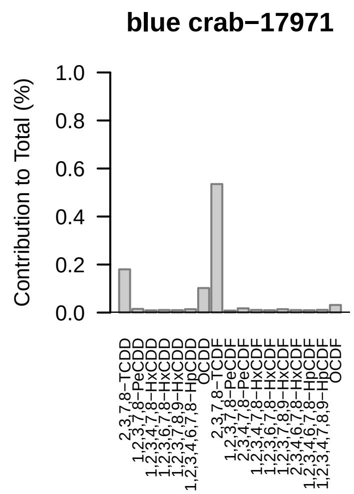

blue crab−16618
Contribution to Total (%)
0.0
0.2
0.4
0.6
0.8
1.0
2,3,7,8−TCDD
1,2,3,7,8−PeCDD
1,2,3,4,7,8−HxCDD
1,2,3,6,7,8−HxCDD
1,2,3,7,8,9−HxCDD
1,2,3,4,6,7,8−HpCDD
OCDD
2,3,7,8−TCDF
1,2,3,7,8−PeCDF
2,3,4,7,8−PeCDF
1,2,3,4,7,8−HxCDF
1,2,3,6,7,8−HxCDF
1,2,3,7,8,9−HxCDF
2,3,4,6,7,8−HxCDF
1,2,3,4,6,7,8−HpCDF
1,2,3,4,7,8,9−HpCDF
OCDF

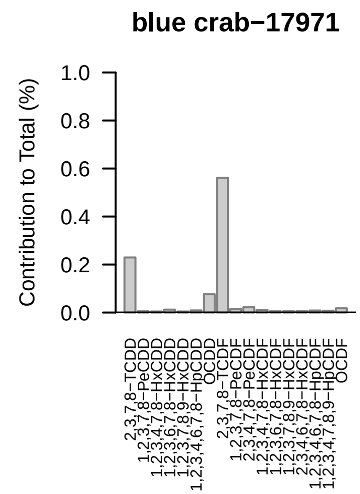

blue crab−16622
Contribution to Total (%)
1.0
0.8
0.6
0.4
0.2
0.0
2,3,7,8−TCDD
1,2,3,7,8−PeCDD
1,2,3,4,7,8−HxCDD
1,2,3,6,7,8−HxCDD
1,2,3,7,8,9−HxCDD
1,2,3,4,6,7,8−HpCDD
OCDD
2,3,7,8−TCDF
1,2,3,7,8−PeCDF
2,3,4,7,8−PeCDF
1,2,3,4,7,8−HxCDF
1,2,3,6,7,8−HxCDF
1,2,3,7,8,9−HxCDF
2,3,4,6,7,8−HxCDF
1,2,3,4,6,7,8−HpCDF
1,2,3,4,7,8,9−HpCDF
OCDF

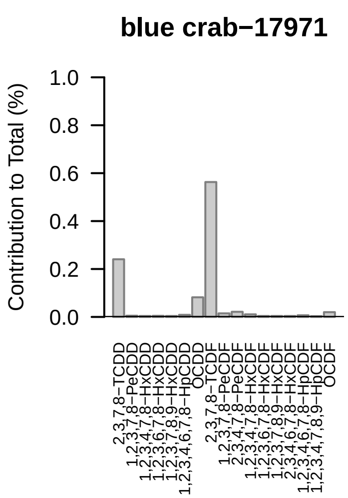

blue crab−16622
Contribution to Total (%)
1.0
0.8
0.6
0.4
0.2
0.0
2,3,7,8−TCDD
1,2,3,7,8−PeCDD
1,2,3,4,7,8−HxCDD
1,2,3,6,7,8−HxCDD
1,2,3,7,8,9−HxCDD
1,2,3,4,6,7,8−HpCDD
OCDD
2,3,7,8−TCDF
1,2,3,7,8−PeCDF
2,3,4,7,8−PeCDF
1,2,3,4,7,8−HxCDF
1,2,3,6,7,8−HxCDF
1,2,3,7,8,9−HxCDF
2,3,4,6,7,8−HxCDF
1,2,3,4,6,7,8−HpCDF
1,2,3,4,7,8,9−HpCDF
OCDF

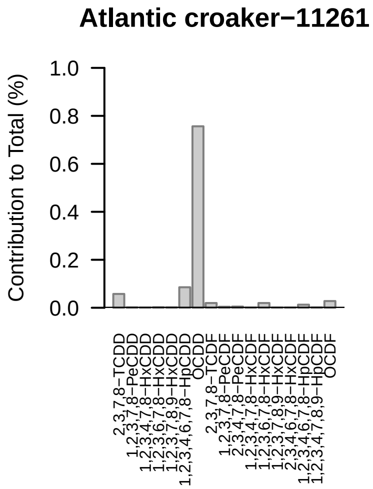

blue crab−17970
Contribution to Total (%)
1.0
0.8
0.6
0.4
0.2
0.0
2,3,7,8−TCDD
1,2,3,7,8−PeCDD
1,2,3,4,7,8−HxCDD
1,2,3,6,7,8−HxCDD
1,2,3,7,8,9−HxCDD
1,2,3,4,6,7,8−HpCDD
OCDD
2,3,7,8−TCDF
1,2,3,7,8−PeCDF
2,3,4,7,8−PeCDF
1,2,3,4,7,8−HxCDF
1,2,3,6,7,8−HxCDF
1,2,3,7,8,9−HxCDF
2,3,4,6,7,8−HxCDF
1,2,3,4,6,7,8−HpCDF
1,2,3,4,7,8,9−HpCDF
OCDF

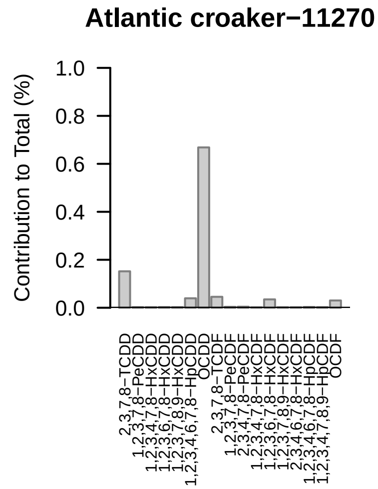

blue crab−17970
Contribution to Total (%)
1.0
0.8
0.6
0.4
0.2
0.0
2,3,7,8−TCDD
1,2,3,7,8−PeCDD
1,2,3,4,7,8−HxCDD
1,2,3,6,7,8−HxCDD
1,2,3,7,8,9−HxCDD
1,2,3,4,6,7,8−HpCDD
OCDD
2,3,7,8−TCDF
1,2,3,7,8−PeCDF
2,3,4,7,8−PeCDF
1,2,3,4,7,8−HxCDF
1,2,3,6,7,8−HxCDF
1,2,3,7,8,9−HxCDF
2,3,4,6,7,8−HxCDF
1,2,3,4,6,7,8−HpCDF
1,2,3,4,7,8,9−HpCDF
OCDF

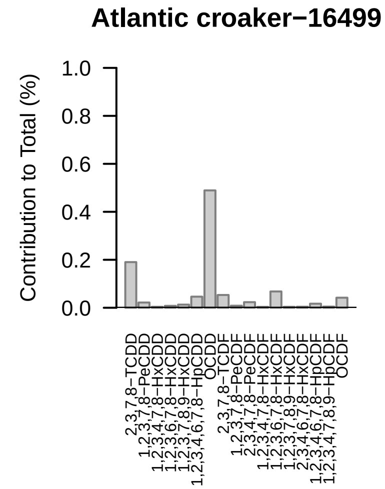

blue crab−17971
Contribution to Total (%)
1.0
0.8
0.6
0.4
0.2
0.0
2,3,7,8−TCDD
1,2,3,7,8−PeCDD
1,2,3,4,7,8−HxCDD
1,2,3,6,7,8−HxCDD
1,2,3,7,8,9−HxCDD
1,2,3,4,6,7,8−HpCDD
OCDD
2,3,7,8−TCDF
1,2,3,7,8−PeCDF
2,3,4,7,8−PeCDF
1,2,3,4,7,8−HxCDF
1,2,3,6,7,8−HxCDF
1,2,3,7,8,9−HxCDF
2,3,4,6,7,8−HxCDF
1,2,3,4,6,7,8−HpCDF
1,2,3,4,7,8,9−HpCDF
OCDF

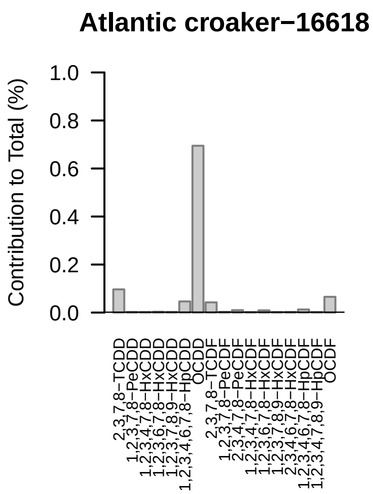

blue crab−17971
Contribution to Total (%)
1.0
0.8
0.6
0.4
0.2
0.0
2,3,7,8−TCDD
1,2,3,7,8−PeCDD
1,2,3,4,7,8−HxCDD
1,2,3,6,7,8−HxCDD
1,2,3,7,8,9−HxCDD
1,2,3,4,6,7,8−HpCDD
OCDD
2,3,7,8−TCDF
1,2,3,7,8−PeCDF
2,3,4,7,8−PeCDF
1,2,3,4,7,8−HxCDF
1,2,3,6,7,8−HxCDF
1,2,3,7,8,9−HxCDF
2,3,4,6,7,8−HxCDF
1,2,3,4,6,7,8−HpCDF
1,2,3,4,7,8,9−HpCDF
OCDF

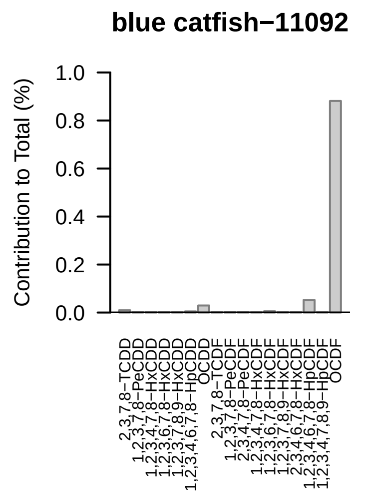

blue crab−17971
Contribution to Total (%)
1.0
0.8
0.6
0.4
0.2
0.0
2,3,7,8−TCDD
1,2,3,7,8−PeCDD
1,2,3,4,7,8−HxCDD
1,2,3,6,7,8−HxCDD
1,2,3,7,8,9−HxCDD
1,2,3,4,6,7,8−HpCDD
OCDD
2,3,7,8−TCDF
1,2,3,7,8−PeCDF
2,3,4,7,8−PeCDF
1,2,3,4,7,8−HxCDF
1,2,3,6,7,8−HxCDF
1,2,3,7,8,9−HxCDF
2,3,4,6,7,8−HxCDF
1,2,3,4,6,7,8−HpCDF
1,2,3,4,7,8,9−HpCDF
OCDF

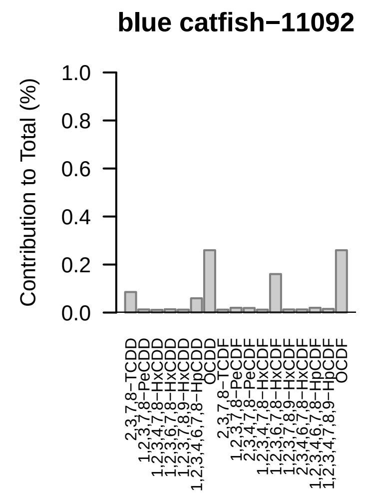

Atlantic croaker−11261
Contribution to Total (%)
0.0
0.2
0.4
0.6
0.8
1.0
2,3,7,8−TCDD
1,2,3,7,8−PeCDD
1,2,3,4,7,8−HxCDD
1,2,3,6,7,8−HxCDD
1,2,3,7,8,9−HxCDD
1,2,3,4,6,7,8−HpCDD
OCDD
2,3,7,8−TCDF
1,2,3,7,8−PeCDF
2,3,4,7,8−PeCDF
1,2,3,4,7,8−HxCDF
1,2,3,6,7,8−HxCDF
1,2,3,7,8,9−HxCDF
2,3,4,6,7,8−HxCDF
1,2,3,4,6,7,8−HpCDF
1,2,3,4,7,8,9−HpCDF
OCDF

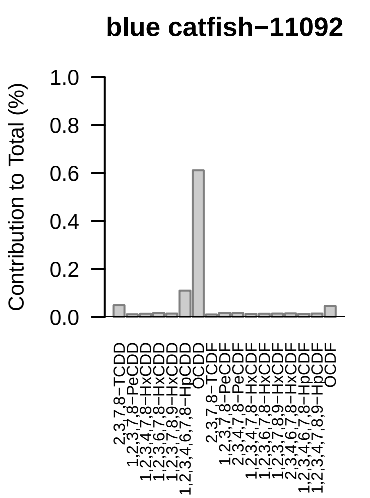

Atlantic croaker−11270
Contribution to Total (%)
0.0
0.2
0.4
0.6
0.8
1.0
2,3,7,8−TCDD
1,2,3,7,8−PeCDD
1,2,3,4,7,8−HxCDD
1,2,3,6,7,8−HxCDD
1,2,3,7,8,9−HxCDD
1,2,3,4,6,7,8−HpCDD
OCDD
2,3,7,8−TCDF
1,2,3,7,8−PeCDF
2,3,4,7,8−PeCDF
1,2,3,4,7,8−HxCDF
1,2,3,6,7,8−HxCDF
1,2,3,7,8,9−HxCDF
2,3,4,6,7,8−HxCDF
1,2,3,4,6,7,8−HpCDF
1,2,3,4,7,8,9−HpCDF
OCDF

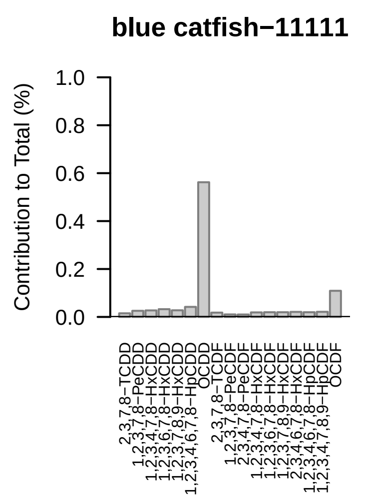

Atlantic croaker−16499
Contribution to Total (%)
0.0
0.2
0.4
0.6
0.8
1.0
2,3,7,8−TCDD
1,2,3,7,8−PeCDD
1,2,3,4,7,8−HxCDD
1,2,3,6,7,8−HxCDD
1,2,3,7,8,9−HxCDD
1,2,3,4,6,7,8−HpCDD
OCDD
2,3,7,8−TCDF
1,2,3,7,8−PeCDF
2,3,4,7,8−PeCDF
1,2,3,4,7,8−HxCDF
1,2,3,6,7,8−HxCDF
1,2,3,7,8,9−HxCDF
2,3,4,6,7,8−HxCDF
1,2,3,4,6,7,8−HpCDF
1,2,3,4,7,8,9−HpCDF
OCDF

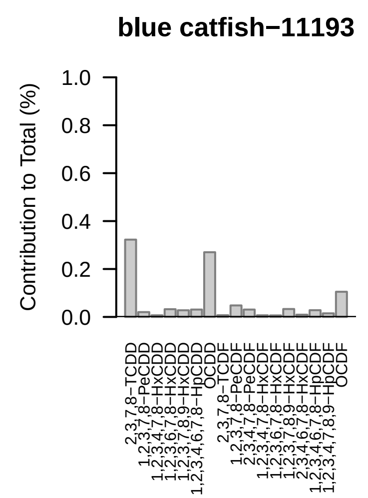

Atlantic croaker−16618
Contribution to Total (%)
0.0
0.2
0.4
0.6
0.8
1.0
2,3,7,8−TCDD
1,2,3,7,8−PeCDD
1,2,3,4,7,8−HxCDD
1,2,3,6,7,8−HxCDD
1,2,3,7,8,9−HxCDD
1,2,3,4,6,7,8−HpCDD
OCDD
2,3,7,8−TCDF
1,2,3,7,8−PeCDF
2,3,4,7,8−PeCDF
1,2,3,4,7,8−HxCDF
1,2,3,6,7,8−HxCDF
1,2,3,7,8,9−HxCDF
2,3,4,6,7,8−HxCDF
1,2,3,4,6,7,8−HpCDF
1,2,3,4,7,8,9−HpCDF
OCDF

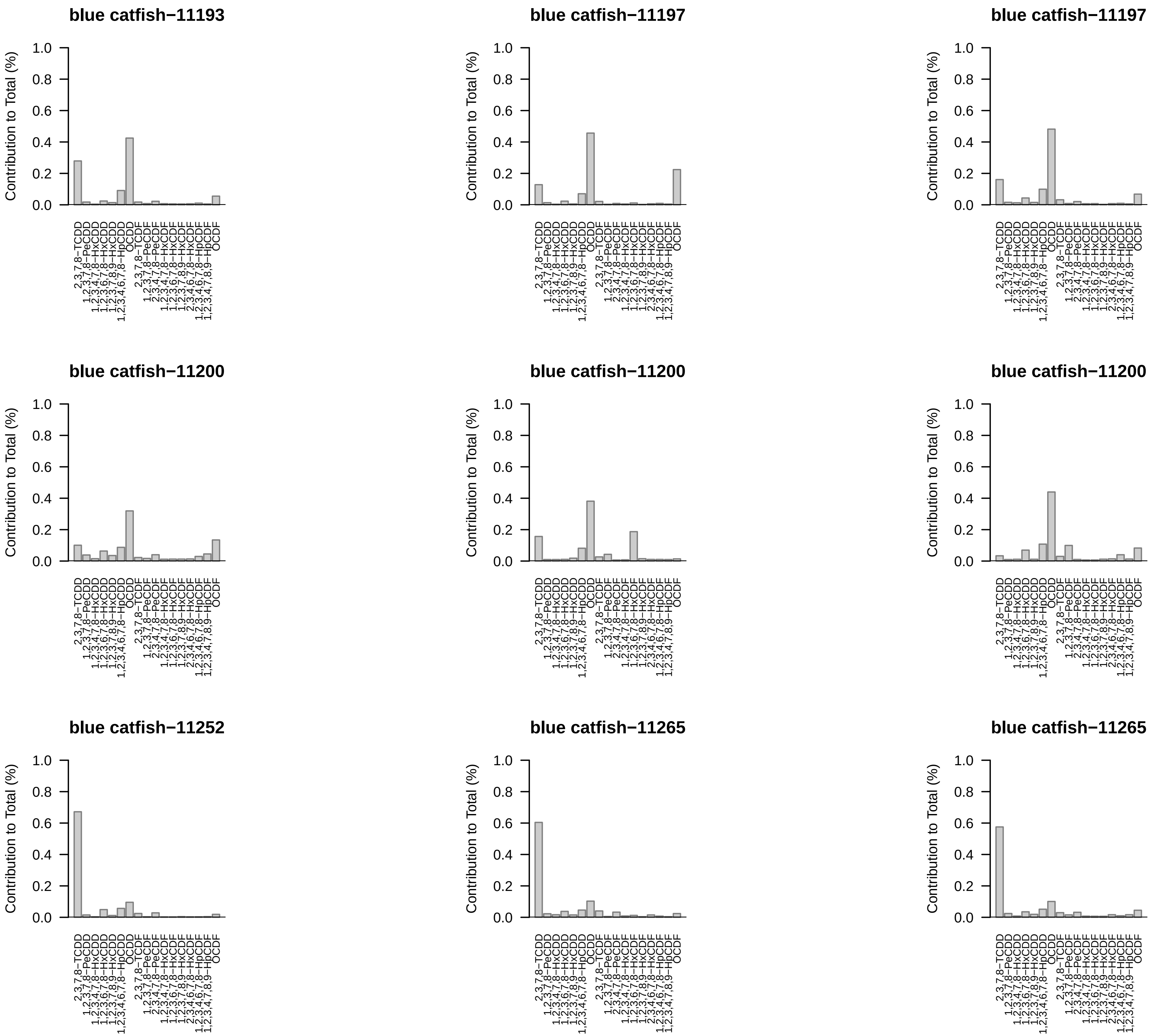

blue catfish−11092
Contribution to Total (%)
0.0
0.2
0.4
0.6
0.8
1.0
2,3,7,8−TCDD
1,2,3,7,8−PeCDD
1,2,3,4,7,8−HxCDD
1,2,3,6,7,8−HxCDD
1,2,3,7,8,9−HxCDD
1,2,3,4,6,7,8−HpCDD
OCDD
2,3,7,8−TCDF
1,2,3,7,8−PeCDF
2,3,4,7,8−PeCDF
1,2,3,4,7,8−HxCDF
1,2,3,6,7,8−HxCDF
1,2,3,7,8,9−HxCDF
2,3,4,6,7,8−HxCDF
1,2,3,4,6,7,8−HpCDF
1,2,3,4,7,8,9−HpCDF
OCDF

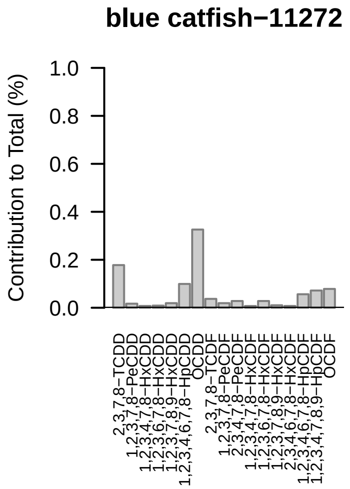

blue catfish−11092
Contribution to Total (%)
0.0
0.2
0.4
0.6
0.8
1.0
2,3,7,8−TCDD
1,2,3,7,8−PeCDD
1,2,3,4,7,8−HxCDD
1,2,3,6,7,8−HxCDD
1,2,3,7,8,9−HxCDD
1,2,3,4,6,7,8−HpCDD
OCDD
2,3,7,8−TCDF
1,2,3,7,8−PeCDF
2,3,4,7,8−PeCDF
1,2,3,4,7,8−HxCDF
1,2,3,6,7,8−HxCDF
1,2,3,7,8,9−HxCDF
2,3,4,6,7,8−HxCDF
1,2,3,4,6,7,8−HpCDF
1,2,3,4,7,8,9−HpCDF
OCDF

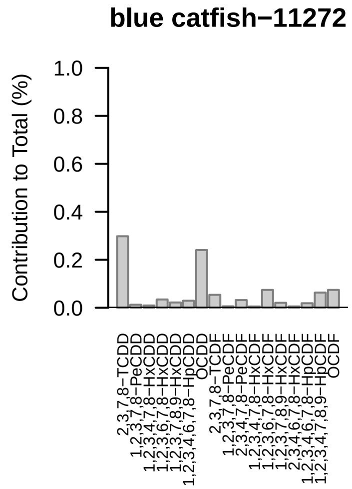

blue catfish−11092
Contribution to Total (%)
0.0
0.2
0.4
0.6
0.8
1.0
2,3,7,8−TCDD
1,2,3,7,8−PeCDD
1,2,3,4,7,8−HxCDD
1,2,3,6,7,8−HxCDD
1,2,3,7,8,9−HxCDD
1,2,3,4,6,7,8−HpCDD
OCDD
2,3,7,8−TCDF
1,2,3,7,8−PeCDF
2,3,4,7,8−PeCDF
1,2,3,4,7,8−HxCDF
1,2,3,6,7,8−HxCDF
1,2,3,7,8,9−HxCDF
2,3,4,6,7,8−HxCDF
1,2,3,4,6,7,8−HpCDF
1,2,3,4,7,8,9−HpCDF
OCDF

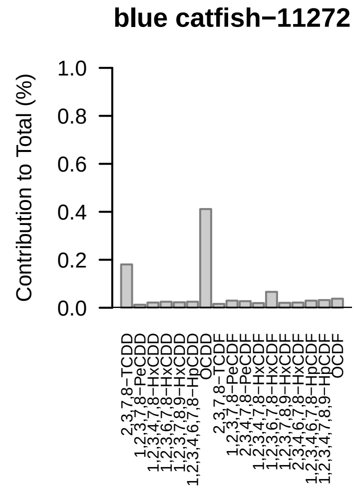

blue catfish−11111
Contribution to Total (%)
0.0
0.2
0.4
0.6
0.8
1.0
2,3,7,8−TCDD
1,2,3,7,8−PeCDD
1,2,3,4,7,8−HxCDD
1,2,3,6,7,8−HxCDD
1,2,3,7,8,9−HxCDD
1,2,3,4,6,7,8−HpCDD
OCDD
2,3,7,8−TCDF
1,2,3,7,8−PeCDF
2,3,4,7,8−PeCDF
1,2,3,4,7,8−HxCDF
1,2,3,6,7,8−HxCDF
1,2,3,7,8,9−HxCDF
2,3,4,6,7,8−HxCDF
1,2,3,4,6,7,8−HpCDF
1,2,3,4,7,8,9−HpCDF
OCDF

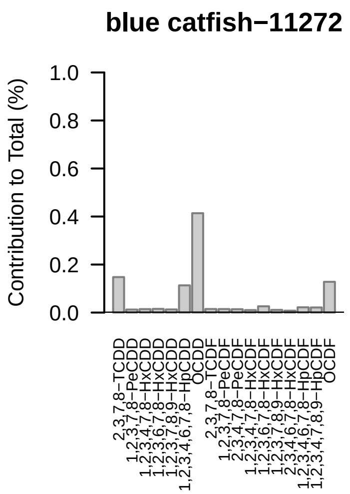

blue catfish−11193
Contribution to Total (%)
0.0
0.2
0.4
0.6
0.8
1.0
2,3,7,8−TCDD
1,2,3,7,8−PeCDD
1,2,3,4,7,8−HxCDD
1,2,3,6,7,8−HxCDD
1,2,3,7,8,9−HxCDD
1,2,3,4,6,7,8−HpCDD
OCDD
2,3,7,8−TCDF
1,2,3,7,8−PeCDF
2,3,4,7,8−PeCDF
1,2,3,4,7,8−HxCDF
1,2,3,6,7,8−HxCDF
1,2,3,7,8,9−HxCDF
2,3,4,6,7,8−HxCDF
1,2,3,4,6,7,8−HpCDF
1,2,3,4,7,8,9−HpCDF
OCDF

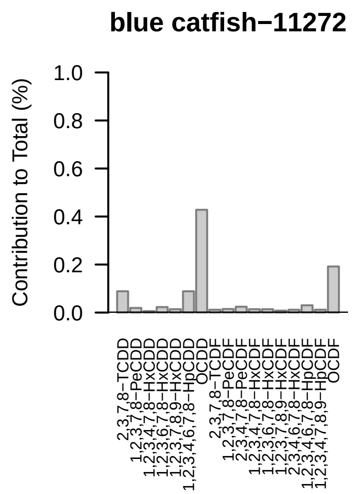

blue catfish−11193
blue catfish−11197
blue catfish−11197
blue catfish−11200
blue catfish−11200
blue catfish−11200
blue catfish−11252
blue catfish−11265
blue catfish−11265
Contribution to Total (%)
1.0
0.8
0.6
0.4
0.2
0.0
2,3,7,8−TCDD
1,2,3,7,8−PeCDD
1,2,3,4,7,8−HxCDD
1,2,3,6,7,8−HxCDD
1,2,3,7,8,9−HxCDD
1,2,3,4,6,7,8−HpCDD
OCDD
2,3,7,8−TCDF
1,2,3,7,8−PeCDF
2,3,4,7,8−PeCDF
1,2,3,4,7,8−HxCDF
1,2,3,6,7,8−HxCDF
1,2,3,7,8,9−HxCDF
2,3,4,6,7,8−HxCDF
1,2,3,4,6,7,8−HpCDF
1,2,3,4,7,8,9−HpCDF
OCDF

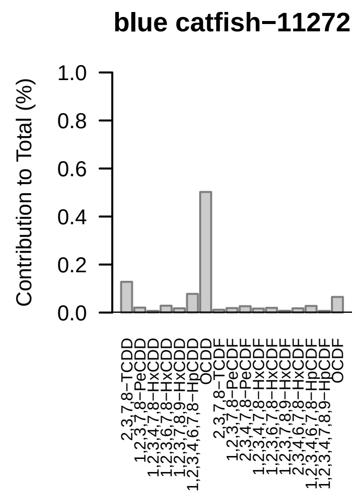

blue catfish−11272
Contribution to Total (%)
1.0
0.8
0.6
0.4
0.2
0.0
2,3,7,8−TCDD
1,2,3,7,8−PeCDD
1,2,3,4,7,8−HxCDD
1,2,3,6,7,8−HxCDD
1,2,3,7,8,9−HxCDD
1,2,3,4,6,7,8−HpCDD
OCDD
2,3,7,8−TCDF
1,2,3,7,8−PeCDF
2,3,4,7,8−PeCDF
1,2,3,4,7,8−HxCDF
1,2,3,6,7,8−HxCDF
1,2,3,7,8,9−HxCDF
2,3,4,6,7,8−HxCDF
1,2,3,4,6,7,8−HpCDF
1,2,3,4,7,8,9−HpCDF
OCDF

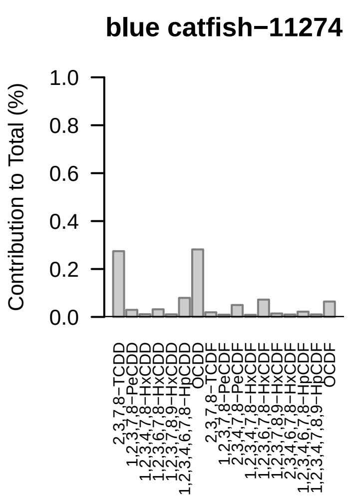

blue catfish−11272
Contribution to Total (%)
1.0
0.8
0.6
0.4
0.2
0.0
2,3,7,8−TCDD
1,2,3,7,8−PeCDD
1,2,3,4,7,8−HxCDD
1,2,3,6,7,8−HxCDD
1,2,3,7,8,9−HxCDD
1,2,3,4,6,7,8−HpCDD
OCDD
2,3,7,8−TCDF
1,2,3,7,8−PeCDF
2,3,4,7,8−PeCDF
1,2,3,4,7,8−HxCDF
1,2,3,6,7,8−HxCDF
1,2,3,7,8,9−HxCDF
2,3,4,6,7,8−HxCDF
1,2,3,4,6,7,8−HpCDF
1,2,3,4,7,8,9−HpCDF
OCDF

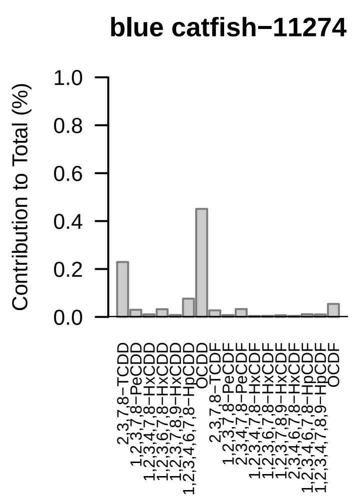

blue catfish−11272
Contribution to Total (%)
1.0
0.8
0.6
0.4
0.2
0.0
2,3,7,8−TCDD
1,2,3,7,8−PeCDD
1,2,3,4,7,8−HxCDD
1,2,3,6,7,8−HxCDD
1,2,3,7,8,9−HxCDD
1,2,3,4,6,7,8−HpCDD
OCDD
2,3,7,8−TCDF
1,2,3,7,8−PeCDF
2,3,4,7,8−PeCDF
1,2,3,4,7,8−HxCDF
1,2,3,6,7,8−HxCDF
1,2,3,7,8,9−HxCDF
2,3,4,6,7,8−HxCDF
1,2,3,4,6,7,8−HpCDF
1,2,3,4,7,8,9−HpCDF
OCDF

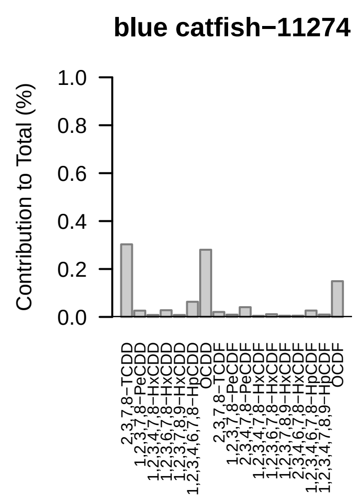

blue catfish−11272
Contribution to Total (%)
1.0
0.8
0.6
0.4
0.2
0.0
2,3,7,8−TCDD
1,2,3,7,8−PeCDD
1,2,3,4,7,8−HxCDD
1,2,3,6,7,8−HxCDD
1,2,3,7,8,9−HxCDD
1,2,3,4,6,7,8−HpCDD
OCDD
2,3,7,8−TCDF
1,2,3,7,8−PeCDF
2,3,4,7,8−PeCDF
1,2,3,4,7,8−HxCDF
1,2,3,6,7,8−HxCDF
1,2,3,7,8,9−HxCDF
2,3,4,6,7,8−HxCDF
1,2,3,4,6,7,8−HpCDF
1,2,3,4,7,8,9−HpCDF
OCDF

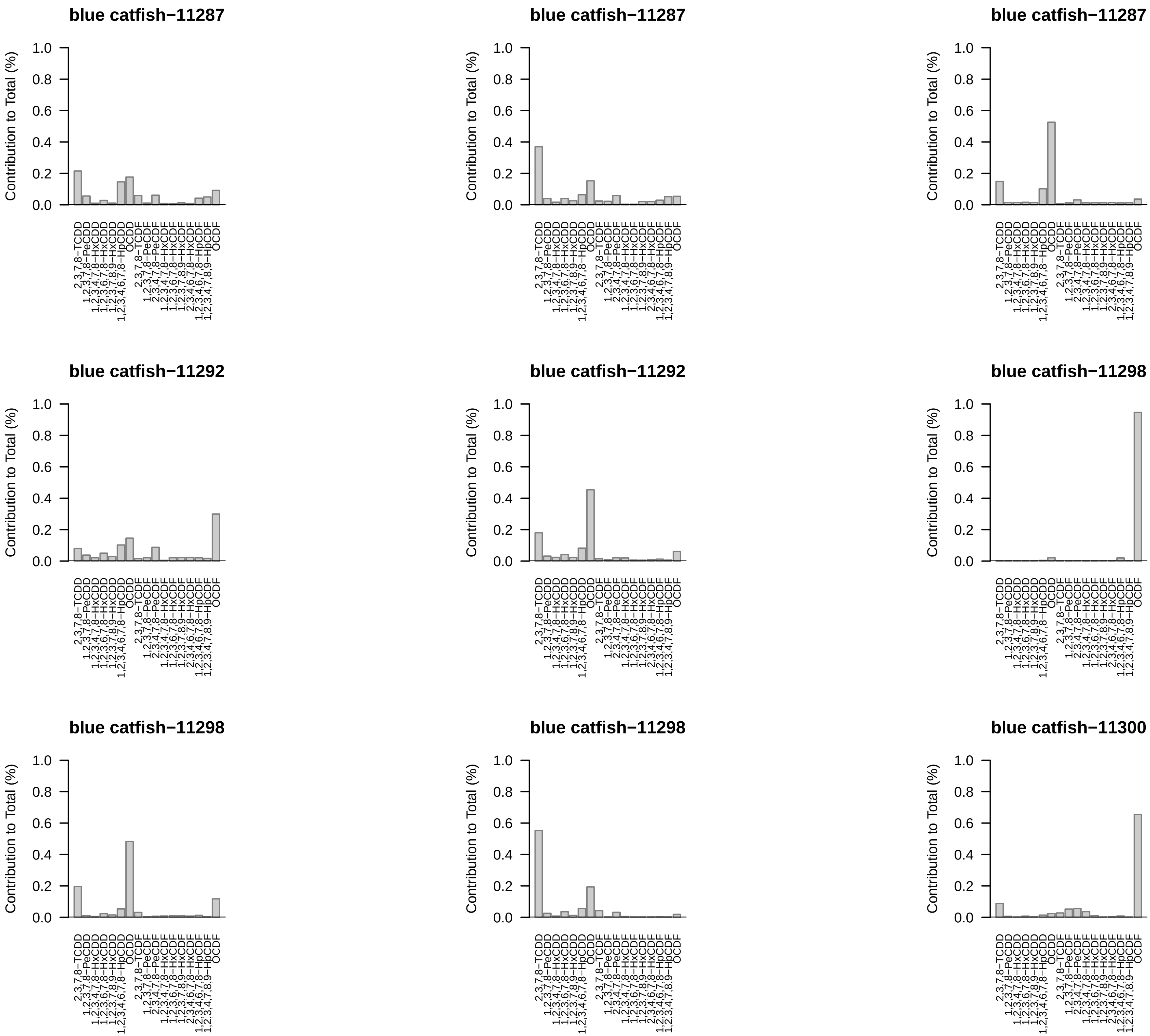

blue catfish−11272
Contribution to Total (%)
1.0
0.8
0.6
0.4
0.2
0.0
2,3,7,8−TCDD
1,2,3,7,8−PeCDD
1,2,3,4,7,8−HxCDD
1,2,3,6,7,8−HxCDD
1,2,3,7,8,9−HxCDD
1,2,3,4,6,7,8−HpCDD
OCDD
2,3,7,8−TCDF
1,2,3,7,8−PeCDF
2,3,4,7,8−PeCDF
1,2,3,4,7,8−HxCDF
1,2,3,6,7,8−HxCDF
1,2,3,7,8,9−HxCDF
2,3,4,6,7,8−HxCDF
1,2,3,4,6,7,8−HpCDF
1,2,3,4,7,8,9−HpCDF
OCDF

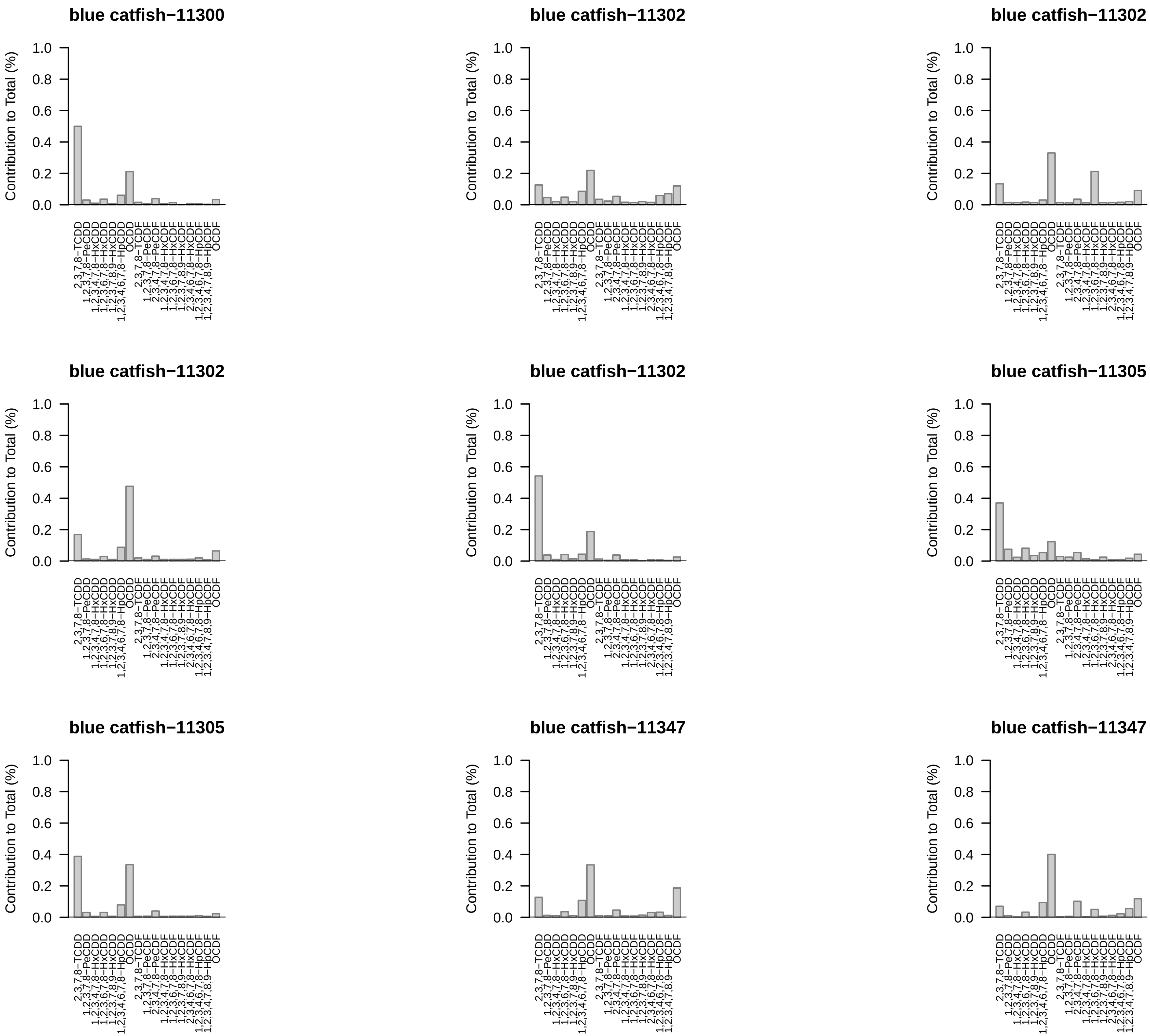

blue catfish−11272
Contribution to Total (%)
1.0
0.8
0.6
0.4
0.2
0.0
2,3,7,8−TCDD
1,2,3,7,8−PeCDD
1,2,3,4,7,8−HxCDD
1,2,3,6,7,8−HxCDD
1,2,3,7,8,9−HxCDD
1,2,3,4,6,7,8−HpCDD
OCDD
2,3,7,8−TCDF
1,2,3,7,8−PeCDF
2,3,4,7,8−PeCDF
1,2,3,4,7,8−HxCDF
1,2,3,6,7,8−HxCDF
1,2,3,7,8,9−HxCDF
2,3,4,6,7,8−HxCDF
1,2,3,4,6,7,8−HpCDF
1,2,3,4,7,8,9−HpCDF
OCDF

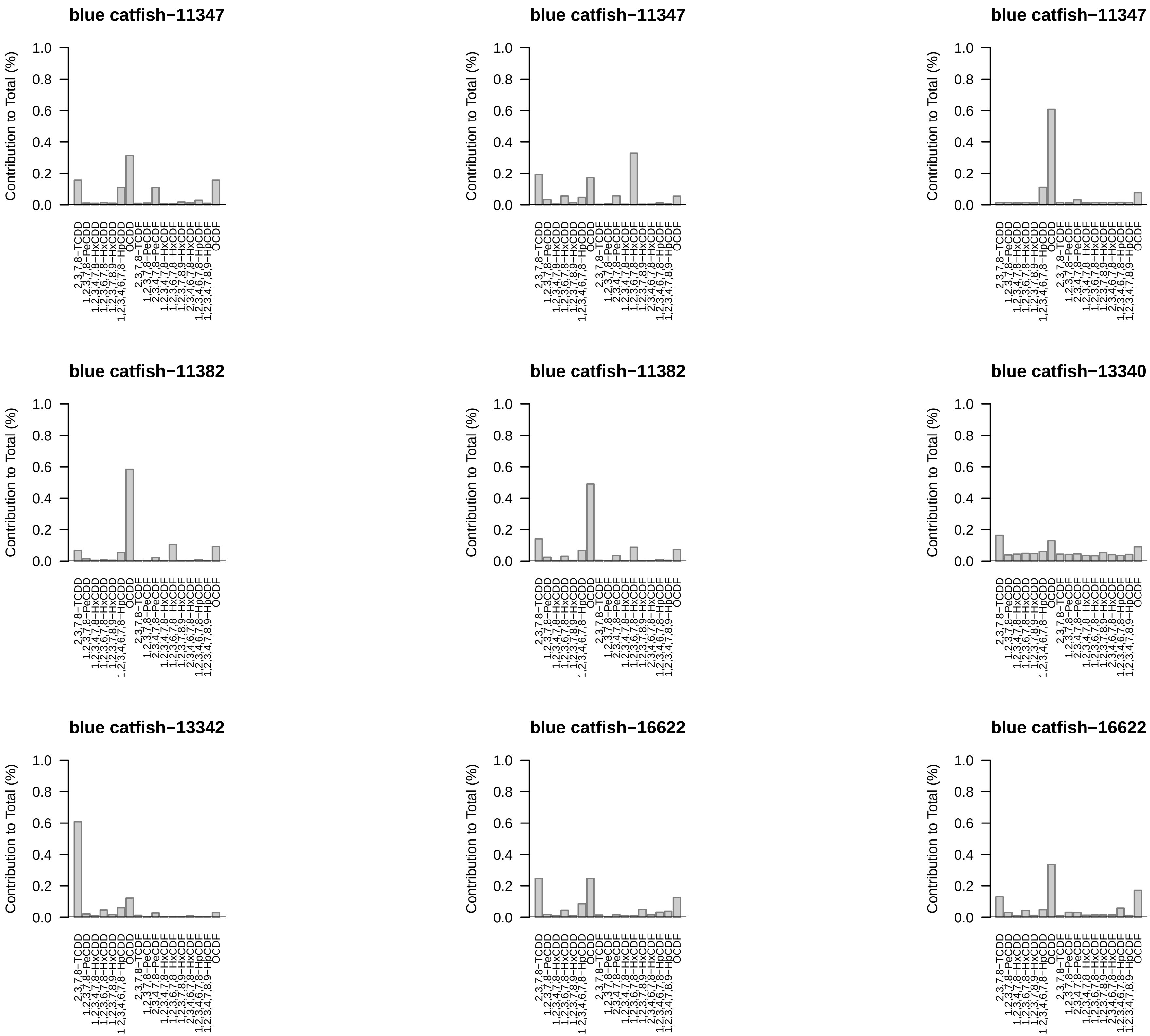

blue catfish−11274
Contribution to Total (%)
1.0
0.8
0.6
0.4
0.2
0.0
2,3,7,8−TCDD
1,2,3,7,8−PeCDD
1,2,3,4,7,8−HxCDD
1,2,3,6,7,8−HxCDD
1,2,3,7,8,9−HxCDD
1,2,3,4,6,7,8−HpCDD
OCDD
2,3,7,8−TCDF
1,2,3,7,8−PeCDF
2,3,4,7,8−PeCDF
1,2,3,4,7,8−HxCDF
1,2,3,6,7,8−HxCDF
1,2,3,7,8,9−HxCDF
2,3,4,6,7,8−HxCDF
1,2,3,4,6,7,8−HpCDF
1,2,3,4,7,8,9−HpCDF
OCDF

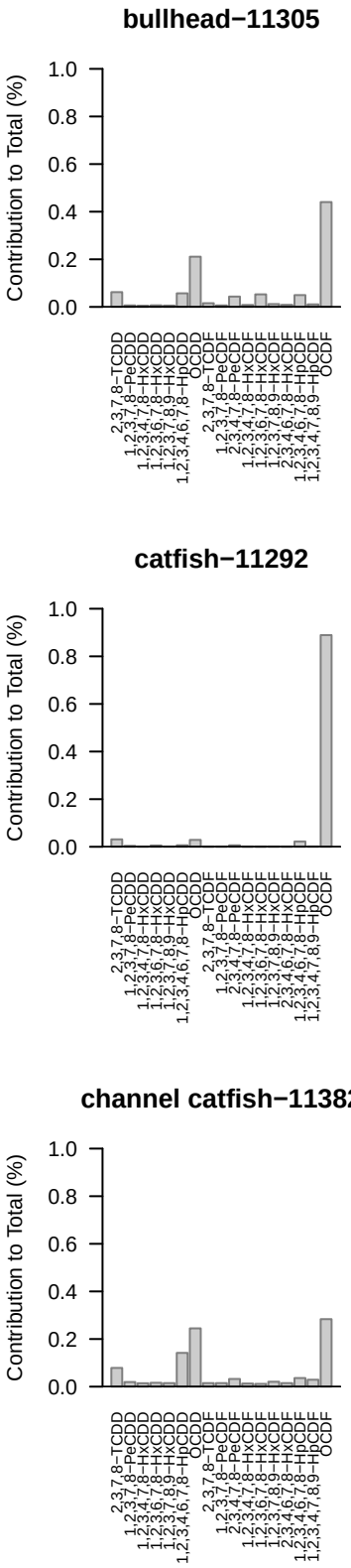

blue catfish−11274
Contribution to Total (%)
1.0
0.8
0.6
0.4
0.2
0.0
2,3,7,8−TCDD
1,2,3,7,8−PeCDD
1,2,3,4,7,8−HxCDD
1,2,3,6,7,8−HxCDD
1,2,3,7,8,9−HxCDD
1,2,3,4,6,7,8−HpCDD
OCDD
2,3,7,8−TCDF
1,2,3,7,8−PeCDF
2,3,4,7,8−PeCDF
1,2,3,4,7,8−HxCDF
1,2,3,6,7,8−HxCDF
1,2,3,7,8,9−HxCDF
2,3,4,6,7,8−HxCDF
1,2,3,4,6,7,8−HpCDF
1,2,3,4,7,8,9−HpCDF
OCDF

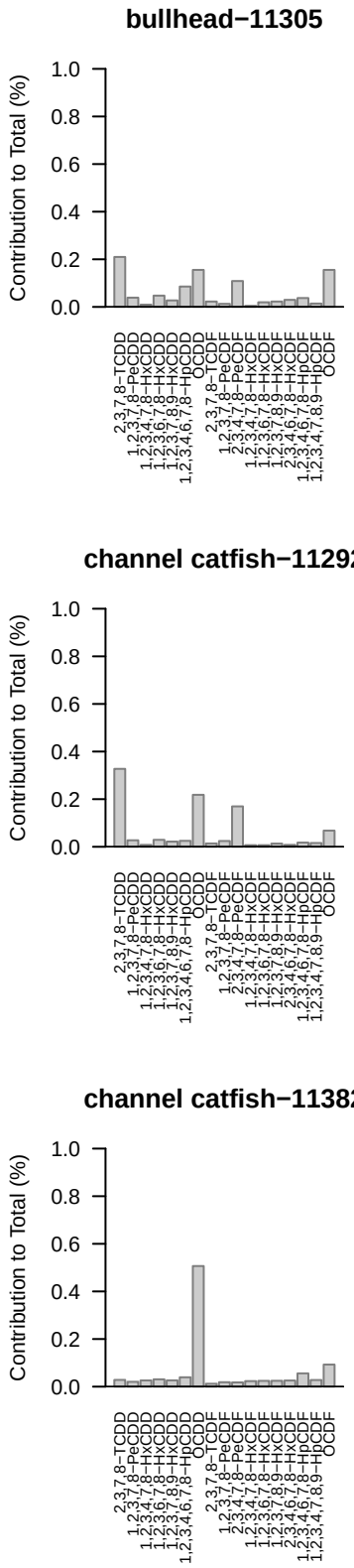

blue catfish−11274
Contribution to Total (%)
1.0
0.8
0.6
0.4
0.2
0.0
2,3,7,8−TCDD
1,2,3,7,8−PeCDD
1,2,3,4,7,8−HxCDD
1,2,3,6,7,8−HxCDD
1,2,3,7,8,9−HxCDD
1,2,3,4,6,7,8−HpCDD
OCDD
2,3,7,8−TCDF
1,2,3,7,8−PeCDF
2,3,4,7,8−PeCDF
1,2,3,4,7,8−HxCDF
1,2,3,6,7,8−HxCDF
1,2,3,7,8,9−HxCDF
2,3,4,6,7,8−HxCDF
1,2,3,4,6,7,8−HpCDF
1,2,3,4,7,8,9−HpCDF
OCDF

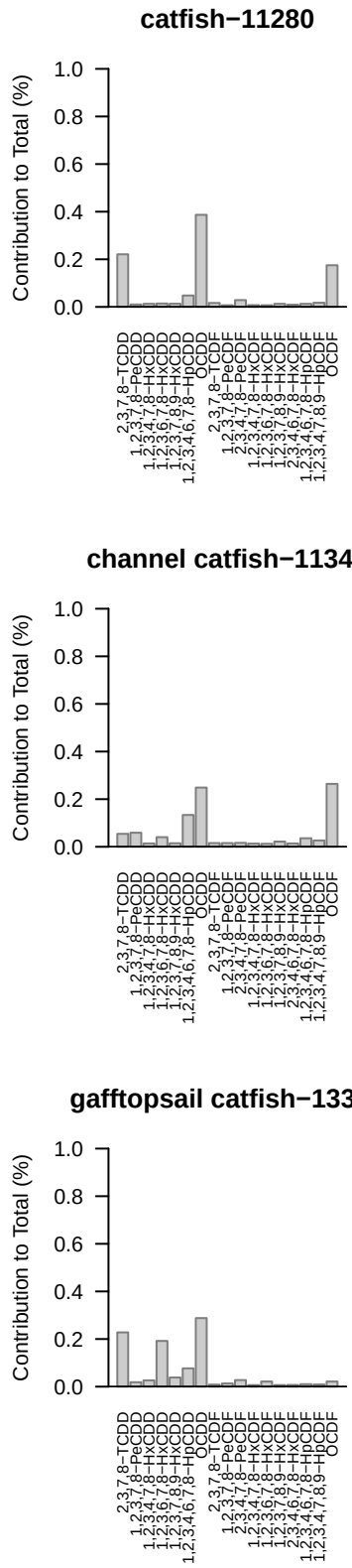

blue catfish−11287
blue catfish−11287
blue catfish−11287
blue catfish−11292
blue catfish−11292
blue catfish−11298
blue catfish−11298
blue catfish−11298
blue catfish−11300
Contribution to Total (%)
0.0
0.2
0.4
0.6
0.8
1.0
2,3,7,8−TCDD
1,2,3,7,8−PeCDD
1,2,3,4,7,8−HxCDD
1,2,3,6,7,8−HxCDD
1,2,3,7,8,9−HxCDD
1,2,3,4,6,7,8−HpCDD
OCDD
2,3,7,8−TCDF
1,2,3,7,8−PeCDF
2,3,4,7,8−PeCDF
1,2,3,4,7,8−HxCDF
1,2,3,6,7,8−HxCDF
1,2,3,7,8,9−HxCDF
2,3,4,6,7,8−HxCDF
1,2,3,4,6,7,8−HpCDF
1,2,3,4,7,8,9−HpCDF
OCDF


blue catfish−11300
blue catfish−11302
blue catfish−11302
blue catfish−11302
blue catfish−11302
blue catfish−11305
blue catfish−11305
blue catfish−11347
blue catfish−11347
Contribution to Total (%)
0.0
0.2
0.4
0.6
0.8
1.0
2,3,7,8−TCDD
1,2,3,7,8−PeCDD
1,2,3,4,7,8−HxCDD
1,2,3,6,7,8−HxCDD
1,2,3,7,8,9−HxCDD
1,2,3,4,6,7,8−HpCDD
OCDD
2,3,7,8−TCDF
1,2,3,7,8−PeCDF
2,3,4,7,8−PeCDF
1,2,3,4,7,8−HxCDF
1,2,3,6,7,8−HxCDF
1,2,3,7,8,9−HxCDF
2,3,4,6,7,8−HxCDF
1,2,3,4,6,7,8−HpCDF
1,2,3,4,7,8,9−HpCDF
OCDF


blue catfish−11347
blue catfish−11347
blue catfish−11347
blue catfish−11382
blue catfish−11382
blue catfish−13340
blue catfish−13342
blue catfish−16622
blue catfish−16622
Contribution to Total (%)
0.0
0.2
0.4
0.6
0.8
1.0
2,3,7,8−TCDD
1,2,3,7,8−PeCDD
1,2,3,4,7,8−HxCDD
1,2,3,6,7,8−HxCDD
1,2,3,7,8,9−HxCDD
1,2,3,4,6,7,8−HpCDD
OCDD
2,3,7,8−TCDF
1,2,3,7,8−PeCDF
2,3,4,7,8−PeCDF
1,2,3,4,7,8−HxCDF
1,2,3,6,7,8−HxCDF
1,2,3,7,8,9−HxCDF
2,3,4,6,7,8−HxCDF
1,2,3,4,6,7,8−HpCDF
1,2,3,4,7,8,9−HpCDF
OCDF


bullhead−11305
Contribution to Total (%)
1.0
0.8
0.6
0.4
0.2
0.0
2,3,7,8−TCDD
1,2,3,7,8−PeCDD
1,2,3,4,7,8−HxCDD
1,2,3,6,7,8−HxCDD
1,2,3,7,8,9−HxCDD
1,2,3,4,6,7,8−HpCDD
OCDD
2,3,7,8−TCDF
1,2,3,7,8−PeCDF
2,3,4,7,8−PeCDF
1,2,3,4,7,8−HxCDF
1,2,3,6,7,8−HxCDF
1,2,3,7,8,9−HxCDF
2,3,4,6,7,8−HxCDF
1,2,3,4,6,7,8−HpCDF
1,2,3,4,7,8,9−HpCDF
OCDF


bullhead−11305
Contribution to Total (%)
1.0
0.8
0.6
0.4
0.2
0.0
2,3,7,8−TCDD
1,2,3,7,8−PeCDD
1,2,3,4,7,8−HxCDD
1,2,3,6,7,8−HxCDD
1,2,3,7,8,9−HxCDD
1,2,3,4,6,7,8−HpCDD
OCDD
2,3,7,8−TCDF
1,2,3,7,8−PeCDF
2,3,4,7,8−PeCDF
1,2,3,4,7,8−HxCDF
1,2,3,6,7,8−HxCDF
1,2,3,7,8,9−HxCDF
2,3,4,6,7,8−HxCDF
1,2,3,4,6,7,8−HpCDF
1,2,3,4,7,8,9−HpCDF
OCDF


catfish−11280
Contribution to Total (%)
1.0
0.8
0.6
0.4
0.2
0.0
2,3,7,8−TCDD
1,2,3,7,8−PeCDD
1,2,3,4,7,8−HxCDD
1,2,3,6,7,8−HxCDD
1,2,3,7,8,9−HxCDD
1,2,3,4,6,7,8−HpCDD
OCDD
2,3,7,8−TCDF
1,2,3,7,8−PeCDF
2,3,4,7,8−PeCDF
1,2,3,4,7,8−HxCDF
1,2,3,6,7,8−HxCDF
1,2,3,7,8,9−HxCDF
2,3,4,6,7,8−HxCDF
1,2,3,4,6,7,8−HpCDF
1,2,3,4,7,8,9−HpCDF
OCDF

catfish−11292
Contribution to Total (%)
1.0
0.8
0.6
0.4
0.2
0.0
2,3,7,8−TCDD
1,2,3,7,8−PeCDD
1,2,3,4,7,8−HxCDD
1,2,3,6,7,8−HxCDD
1,2,3,7,8,9−HxCDD
1,2,3,4,6,7,8−HpCDD
OCDD
2,3,7,8−TCDF
1,2,3,7,8−PeCDF
2,3,4,7,8−PeCDF
1,2,3,4,7,8−HxCDF
1,2,3,6,7,8−HxCDF
1,2,3,7,8,9−HxCDF
2,3,4,6,7,8−HxCDF
1,2,3,4,6,7,8−HpCDF
1,2,3,4,7,8,9−HpCDF
OCDF

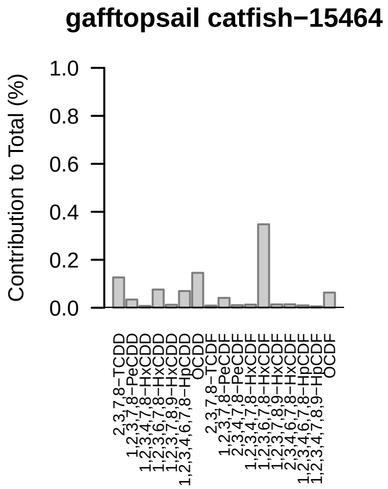
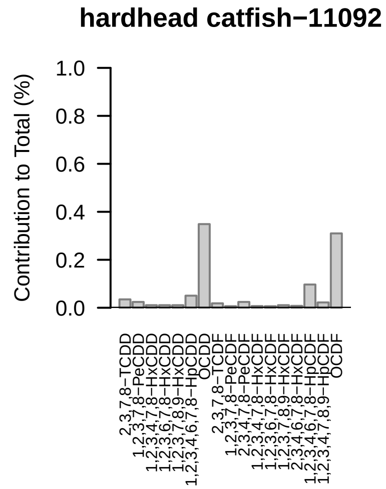
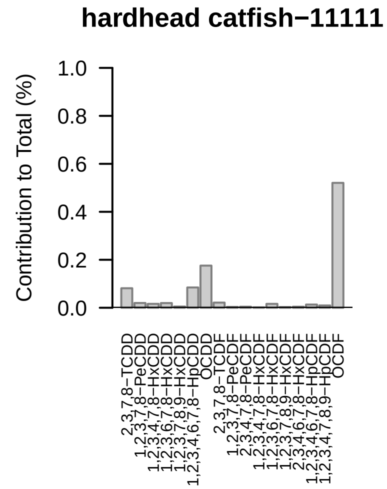
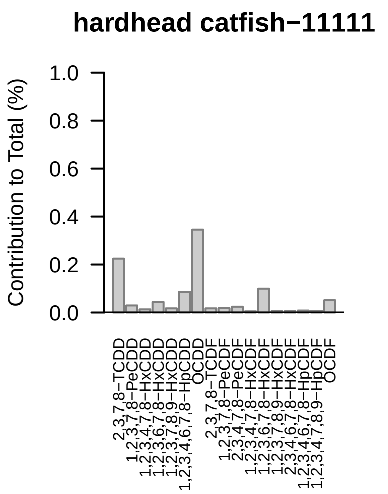
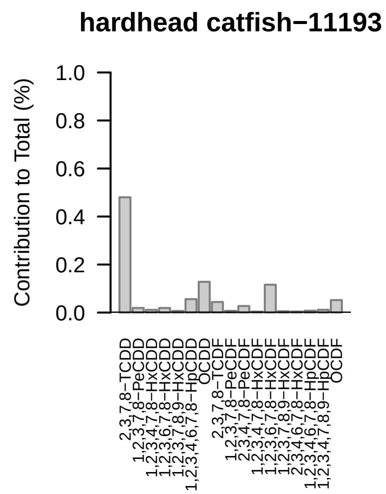
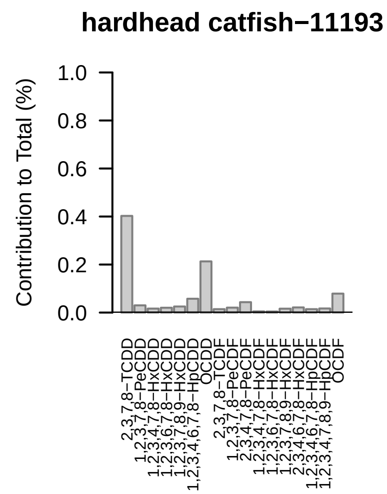
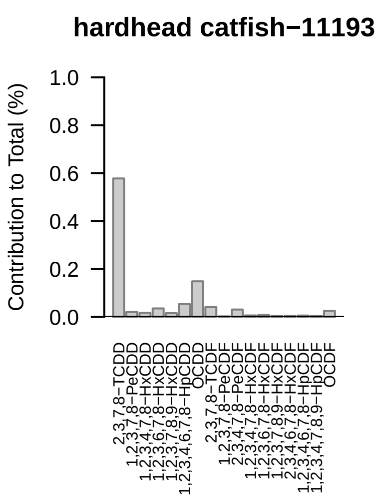
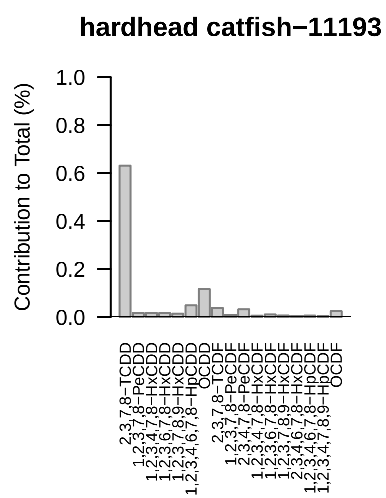
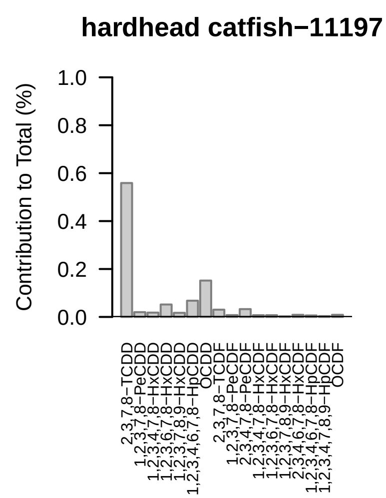
channel catfish−11292
Contribution to Total (%)
1.0
0.8
0.6
0.4
0.2
0.0
2,3,7,8−TCDD
1,2,3,7,8−PeCDD
1,2,3,4,7,8−HxCDD
1,2,3,6,7,8−HxCDD
1,2,3,7,8,9−HxCDD
1,2,3,4,6,7,8−HpCDD
OCDD
2,3,7,8−TCDF
1,2,3,7,8−PeCDF
2,3,4,7,8−PeCDF
1,2,3,4,7,8−HxCDF
1,2,3,6,7,8−HxCDF
1,2,3,7,8,9−HxCDF
2,3,4,6,7,8−HxCDF
1,2,3,4,6,7,8−HpCDF
1,2,3,4,7,8,9−HpCDF
OCDF

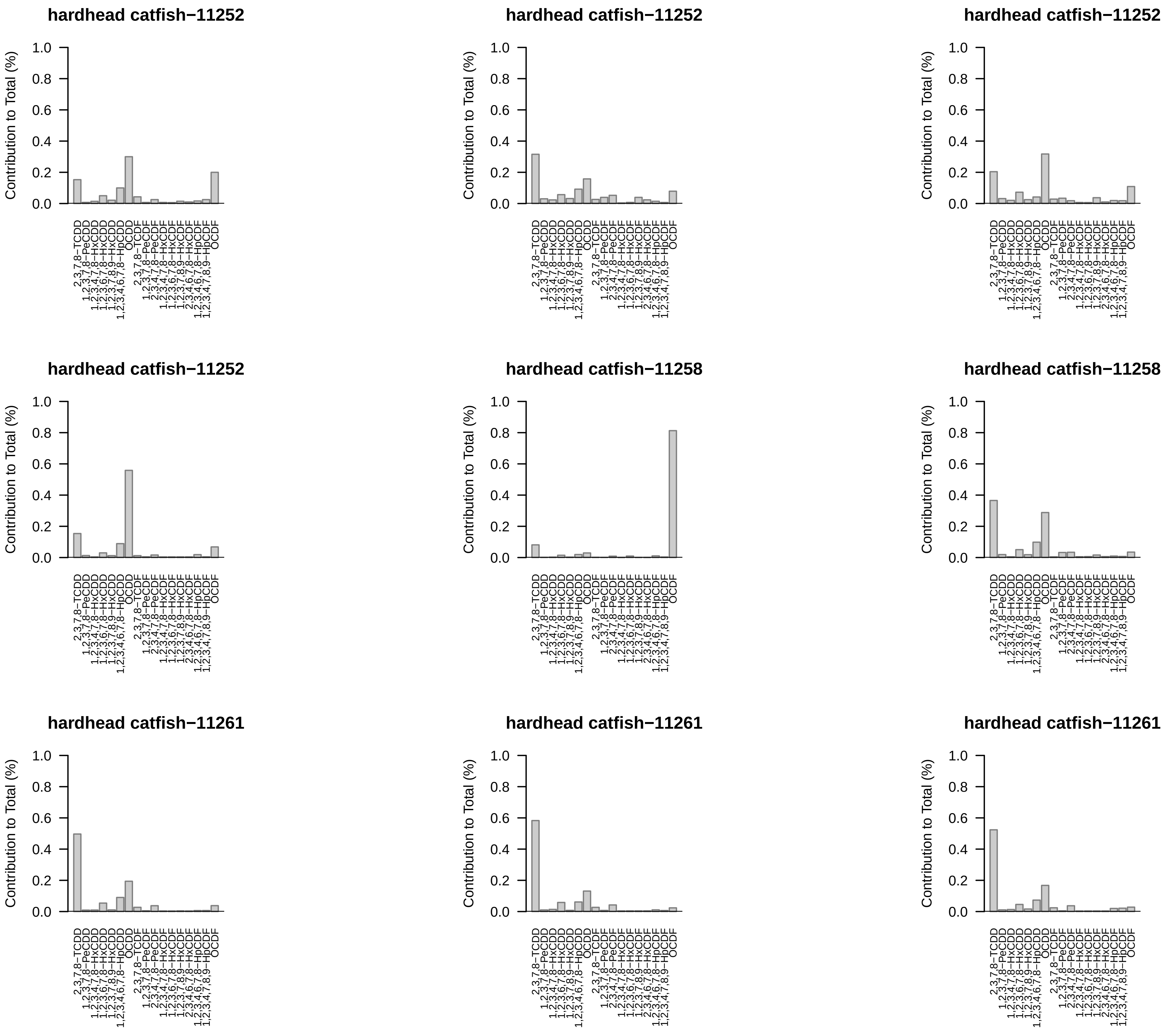
channel catfish−11347
Contribution to Total (%)
1.0
0.8
0.6
0.4
0.2
0.0
2,3,7,8−TCDD
1,2,3,7,8−PeCDD
1,2,3,4,7,8−HxCDD
1,2,3,6,7,8−HxCDD
1,2,3,7,8,9−HxCDD
1,2,3,4,6,7,8−HpCDD
OCDD
2,3,7,8−TCDF
1,2,3,7,8−PeCDF
2,3,4,7,8−PeCDF
1,2,3,4,7,8−HxCDF
1,2,3,6,7,8−HxCDF
1,2,3,7,8,9−HxCDF
2,3,4,6,7,8−HxCDF
1,2,3,4,6,7,8−HpCDF
1,2,3,4,7,8,9−HpCDF
OCDF

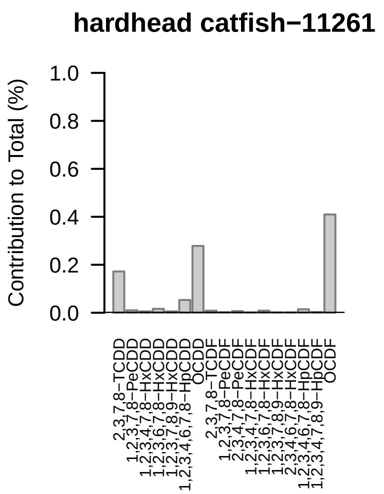
channel catfish−11382
Contribution to Total (%)
1.0
0.8
0.6
0.4
0.2
0.0
2,3,7,8−TCDD
1,2,3,7,8−PeCDD
1,2,3,4,7,8−HxCDD
1,2,3,6,7,8−HxCDD
1,2,3,7,8,9−HxCDD
1,2,3,4,6,7,8−HpCDD
OCDD
2,3,7,8−TCDF
1,2,3,7,8−PeCDF
2,3,4,7,8−PeCDF
1,2,3,4,7,8−HxCDF
1,2,3,6,7,8−HxCDF
1,2,3,7,8,9−HxCDF
2,3,4,6,7,8−HxCDF
1,2,3,4,6,7,8−HpCDF
1,2,3,4,7,8,9−HpCDF
OCDF

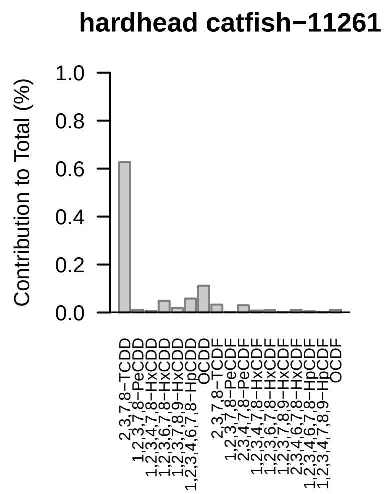
channel catfish−11382
Contribution to Total (%)
1.0
0.8
0.6
0.4
0.2
0.0
2,3,7,8−TCDD
1,2,3,7,8−PeCDD
1,2,3,4,7,8−HxCDD
1,2,3,6,7,8−HxCDD
1,2,3,7,8,9−HxCDD
1,2,3,4,6,7,8−HpCDD
OCDD
2,3,7,8−TCDF
1,2,3,7,8−PeCDF
2,3,4,7,8−PeCDF
1,2,3,4,7,8−HxCDF
1,2,3,6,7,8−HxCDF
1,2,3,7,8,9−HxCDF
2,3,4,6,7,8−HxCDF
1,2,3,4,6,7,8−HpCDF
1,2,3,4,7,8,9−HpCDF
OCDF

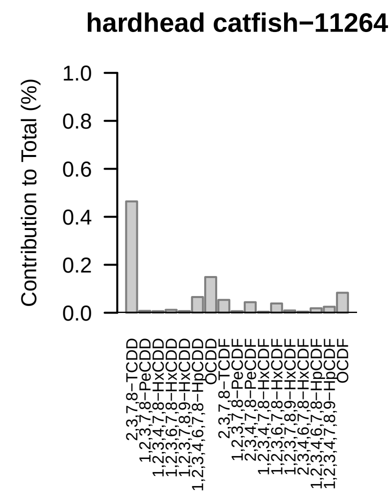
gafftopsail catfish−13309
Contribution to Total (%)
1.0
0.8
0.6
0.4
0.2
0.0
2,3,7,8−TCDD
1,2,3,7,8−PeCDD
1,2,3,4,7,8−HxCDD
1,2,3,6,7,8−HxCDD
1,2,3,7,8,9−HxCDD
1,2,3,4,6,7,8−HpCDD
OCDD
2,3,7,8−TCDF
1,2,3,7,8−PeCDF
2,3,4,7,8−PeCDF
1,2,3,4,7,8−HxCDF
1,2,3,6,7,8−HxCDF
1,2,3,7,8,9−HxCDF
2,3,4,6,7,8−HxCDF
1,2,3,4,6,7,8−HpCDF
1,2,3,4,7,8,9−HpCDF
OCDF

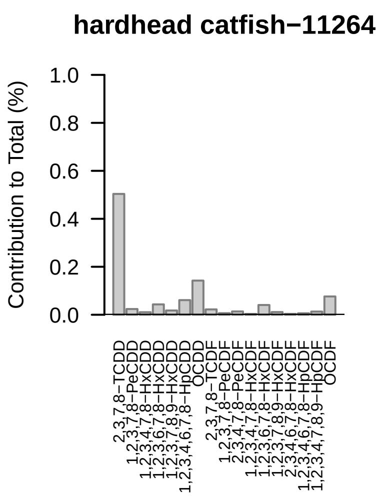

gafftopsail catfish−15464
Contribution to Total (%)
0.0 0.2 0.4 0.6 0.8 1.0
2,3,7,8−TCDD
1,2,3,7,8−PeCDD
1,2,3,4,7,8−HxCDD
1,2,3,6,7,8−HxCDD
1,2,3,7,8,9−HxCDD
1,2,3,4,6,7,8−HpCDD
OCDD
2,3,7,8−TCDF
1,2,3,7,8−PeCDF
2,3,4,7,8−PeCDF
1,2,3,4,7,8−HxCDF
1,2,3,6,7,8−HxCDF
1,2,3,7,8,9−HxCDF
2,3,4,6,7,8−HxCDF
1,2,3,4,6,7,8−HpCDF
1,2,3,4,7,8,9−HpCDF
OCDF

hardhead catfish−11092
Contribution to Total (%)
0.0 0.2 0.4 0.6 0.8 1.0
2,3,7,8−TCDD
1,2,3,7,8−PeCDD
1,2,3,4,7,8−HxCDD
1,2,3,6,7,8−HxCDD
1,2,3,7,8,9−HxCDD
1,2,3,4,6,7,8−HpCDD
OCDD
2,3,7,8−TCDF
1,2,3,7,8−PeCDF
2,3,4,7,8−PeCDF
1,2,3,4,7,8−HxCDF
1,2,3,6,7,8−HxCDF
1,2,3,7,8,9−HxCDF
2,3,4,6,7,8−HxCDF
1,2,3,4,6,7,8−HpCDF
1,2,3,4,7,8,9−HpCDF
OCDF

hardhead catfish−11111
Contribution to Total (%)
0.0 0.2 0.4 0.6 0.8 1.0
2,3,7,8−TCDD
1,2,3,7,8−PeCDD
1,2,3,4,7,8−HxCDD
1,2,3,6,7,8−HxCDD
1,2,3,7,8,9−HxCDD
1,2,3,4,6,7,8−HpCDD
OCDD
2,3,7,8−TCDF
1,2,3,7,8−PeCDF
2,3,4,7,8−PeCDF
1,2,3,4,7,8−HxCDF
1,2,3,6,7,8−HxCDF
1,2,3,7,8,9−HxCDF
2,3,4,6,7,8−HxCDF
1,2,3,4,6,7,8−HpCDF
1,2,3,4,7,8,9−HpCDF
OCDF

hardhead catfish−11111
Contribution to Total (%)
0.0 0.2 0.4 0.6 0.8 1.0
2,3,7,8−TCDD
1,2,3,7,8−PeCDD
1,2,3,4,7,8−HxCDD
1,2,3,6,7,8−HxCDD
1,2,3,7,8,9−HxCDD
1,2,3,4,6,7,8−HpCDD
OCDD
2,3,7,8−TCDF
1,2,3,7,8−PeCDF
2,3,4,7,8−PeCDF
1,2,3,4,7,8−HxCDF
1,2,3,6,7,8−HxCDF
1,2,3,7,8,9−HxCDF
2,3,4,6,7,8−HxCDF
1,2,3,4,6,7,8−HpCDF
1,2,3,4,7,8,9−HpCDF
OCDF

hardhead catfish−11193
Contribution to Total (%)
0.0 0.2 0.4 0.6 0.8 1.0
2,3,7,8−TCDD
1,2,3,7,8−PeCDD
1,2,3,4,7,8−HxCDD
1,2,3,6,7,8−HxCDD
1,2,3,7,8,9−HxCDD
1,2,3,4,6,7,8−HpCDD
OCDD
2,3,7,8−TCDF
1,2,3,7,8−PeCDF
2,3,4,7,8−PeCDF
1,2,3,4,7,8−HxCDF
1,2,3,6,7,8−HxCDF
1,2,3,7,8,9−HxCDF
2,3,4,6,7,8−HxCDF
1,2,3,4,6,7,8−HpCDF
1,2,3,4,7,8,9−HpCDF
OCDF

hardhead catfish−11193
Contribution to Total (%)
0.0 0.2 0.4 0.6 0.8 1.0
2,3,7,8−TCDD
1,2,3,7,8−PeCDD
1,2,3,4,7,8−HxCDD
1,2,3,6,7,8−HxCDD
1,2,3,7,8,9−HxCDD
1,2,3,4,6,7,8−HpCDD
OCDD
2,3,7,8−TCDF
1,2,3,7,8−PeCDF
2,3,4,7,8−PeCDF
1,2,3,4,7,8−HxCDF
1,2,3,6,7,8−HxCDF
1,2,3,7,8,9−HxCDF
2,3,4,6,7,8−HxCDF
1,2,3,4,6,7,8−HpCDF
1,2,3,4,7,8,9−HpCDF
OCDF

hardhead catfish−11193
Contribution to Total (%)
0.0 0.2 0.4 0.6 0.8 1.0
2,3,7,8−TCDD
1,2,3,7,8−PeCDD
1,2,3,4,7,8−HxCDD
1,2,3,6,7,8−HxCDD
1,2,3,7,8,9−HxCDD
1,2,3,4,6,7,8−HpCDD
OCDD
2,3,7,8−TCDF
1,2,3,7,8−PeCDF
2,3,4,7,8−PeCDF
1,2,3,4,7,8−HxCDF
1,2,3,6,7,8−HxCDF
1,2,3,7,8,9−HxCDF
2,3,4,6,7,8−HxCDF
1,2,3,4,6,7,8−HpCDF
1,2,3,4,7,8,9−HpCDF
OCDF

hardhead catfish−11193
Contribution to Total (%)
0.0 0.2 0.4 0.6 0.8 1.0
2,3,7,8−TCDD
1,2,3,7,8−PeCDD
1,2,3,4,7,8−HxCDD
1,2,3,6,7,8−HxCDD
1,2,3,7,8,9−HxCDD
1,2,3,4,6,7,8−HpCDD
OCDD
2,3,7,8−TCDF
1,2,3,7,8−PeCDF
2,3,4,7,8−PeCDF
1,2,3,4,7,8−HxCDF
1,2,3,6,7,8−HxCDF
1,2,3,7,8,9−HxCDF
2,3,4,6,7,8−HxCDF
1,2,3,4,6,7,8−HpCDF
1,2,3,4,7,8,9−HpCDF
OCDF

hardhead catfish−11197
Contribution to Total (%)
0.0 0.2 0.4 0.6 0.8 1.0
2,3,7,8−TCDD
1,2,3,7,8−PeCDD
1,2,3,4,7,8−HxCDD
1,2,3,6,7,8−HxCDD
1,2,3,7,8,9−HxCDD
1,2,3,4,6,7,8−HpCDD
OCDD
2,3,7,8−TCDF
1,2,3,7,8−PeCDF
2,3,4,7,8−PeCDF
1,2,3,4,7,8−HxCDF
1,2,3,6,7,8−HxCDF
1,2,3,7,8,9−HxCDF
2,3,4,6,7,8−HxCDF
1,2,3,4,6,7,8−HpCDF
1,2,3,4,7,8,9−HpCDF
OCDF

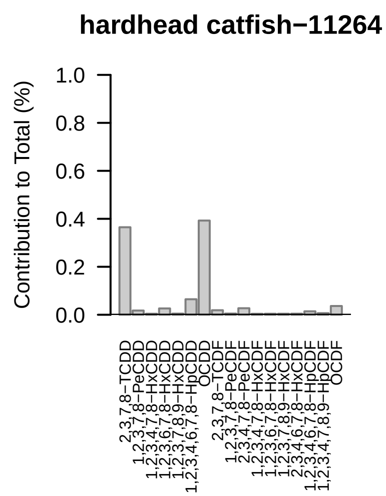

hardhead catfish−11252
hardhead catfish−11252
hardhead catfish−11252
hardhead catfish−11252
hardhead catfish−11258
hardhead catfish−11258
hardhead catfish−11261
hardhead catfish−11261
hardhead catfish−11261
Contribution to Total (%)
0.0
0.2
0.4
0.6
0.8
1.0
2,3,7,8−TCDD
1,2,3,7,8−PeCDD
1,2,3,4,7,8−HxCDD
1,2,3,6,7,8−HxCDD
1,2,3,7,8,9−HxCDD
1,2,3,4,6,7,8−HpCDD
OCDD
2,3,7,8−TCDF
1,2,3,7,8−PeCDF
2,3,4,7,8−PeCDF
1,2,3,4,7,8−HxCDF
1,2,3,6,7,8−HxCDF
1,2,3,7,8,9−HxCDF
2,3,4,6,7,8−HxCDF
1,2,3,4,6,7,8−HpCDF
1,2,3,4,7,8,9−HpCDF
OCDF

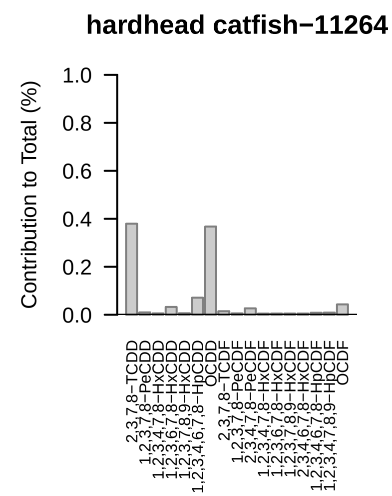

hardhead catfish−11261
Contribution to Total (%)
0.0
0.2
0.4
0.6
0.8
1.0
2,3,7,8−TCDD
1,2,3,7,8−PeCDD
1,2,3,4,7,8−HxCDD
1,2,3,6,7,8−HxCDD
1,2,3,7,8,9−HxCDD
1,2,3,4,6,7,8−HpCDD
OCDD
2,3,7,8−TCDF
1,2,3,7,8−PeCDF
2,3,4,7,8−PeCDF
1,2,3,4,7,8−HxCDF
1,2,3,6,7,8−HxCDF
1,2,3,7,8,9−HxCDF
2,3,4,6,7,8−HxCDF
1,2,3,4,6,7,8−HpCDF
1,2,3,4,7,8,9−HpCDF
OCDF

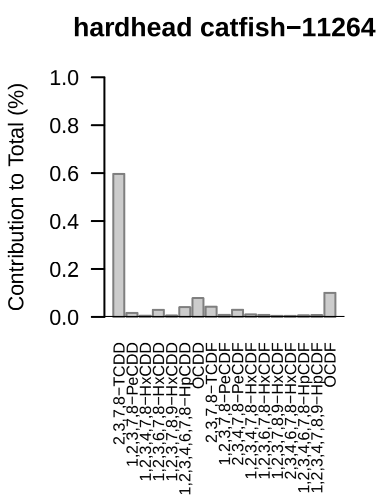

hardhead catfish−11261
Contribution to Total (%)
0.0
0.2
0.4
0.6
0.8
1.0
2,3,7,8−TCDD
1,2,3,7,8−PeCDD
1,2,3,4,7,8−HxCDD
1,2,3,6,7,8−HxCDD
1,2,3,7,8,9−HxCDD
1,2,3,4,6,7,8−HpCDD
OCDD
2,3,7,8−TCDF
1,2,3,7,8−PeCDF
2,3,4,7,8−PeCDF
1,2,3,4,7,8−HxCDF
1,2,3,6,7,8−HxCDF
1,2,3,7,8,9−HxCDF
2,3,4,6,7,8−HxCDF
1,2,3,4,6,7,8−HpCDF
1,2,3,4,7,8,9−HpCDF
OCDF

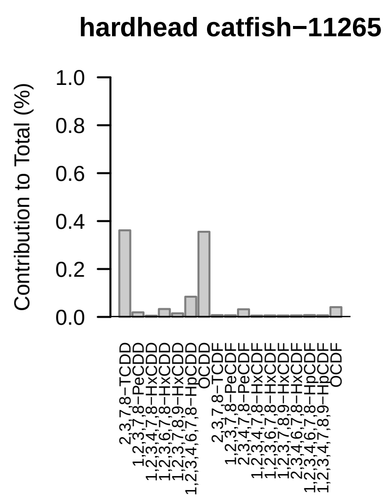

hardhead catfish−11264
Contribution to Total (%)
0.0
0.2
0.4
0.6
0.8
1.0
2,3,7,8−TCDD
1,2,3,7,8−PeCDD
1,2,3,4,7,8−HxCDD
1,2,3,6,7,8−HxCDD
1,2,3,7,8,9−HxCDD
1,2,3,4,6,7,8−HpCDD
OCDD
2,3,7,8−TCDF
1,2,3,7,8−PeCDF
2,3,4,7,8−PeCDF
1,2,3,4,7,8−HxCDF
1,2,3,6,7,8−HxCDF
1,2,3,7,8,9−HxCDF
2,3,4,6,7,8−HxCDF
1,2,3,4,6,7,8−HpCDF
1,2,3,4,7,8,9−HpCDF
OCDF

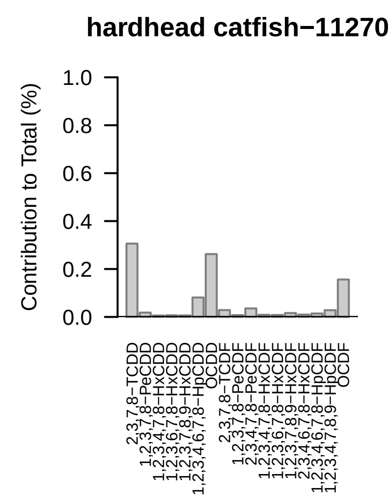

hardhead catfish−11264
Contribution to Total (%)
0.0
0.2
0.4
0.6
0.8
1.0
2,3,7,8−TCDD
1,2,3,7,8−PeCDD
1,2,3,4,7,8−HxCDD
1,2,3,6,7,8−HxCDD
1,2,3,7,8,9−HxCDD
1,2,3,4,6,7,8−HpCDD
OCDD
2,3,7,8−TCDF
1,2,3,7,8−PeCDF
2,3,4,7,8−PeCDF
1,2,3,4,7,8−HxCDF
1,2,3,6,7,8−HxCDF
1,2,3,7,8,9−HxCDF
2,3,4,6,7,8−HxCDF
1,2,3,4,6,7,8−HpCDF
1,2,3,4,7,8,9−HpCDF
OCDF

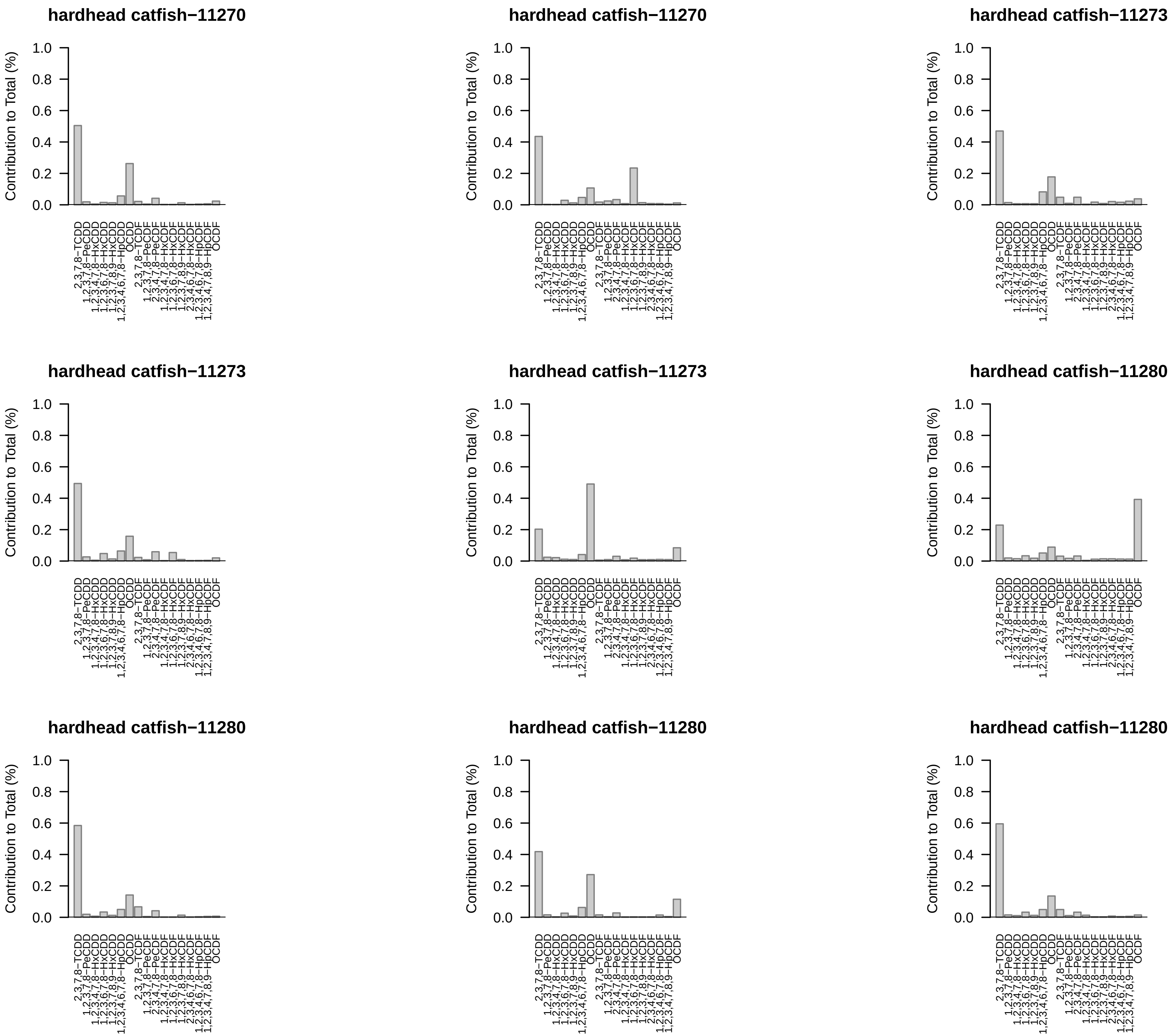

hardhead catfish−11264
Contribution to Total (%)
0.0
0.2
0.4
0.6
0.8
1.0
2,3,7,8−TCDD
1,2,3,7,8−PeCDD
1,2,3,4,7,8−HxCDD
1,2,3,6,7,8−HxCDD
1,2,3,7,8,9−HxCDD
1,2,3,4,6,7,8−HpCDD
OCDD
2,3,7,8−TCDF
1,2,3,7,8−PeCDF
2,3,4,7,8−PeCDF
1,2,3,4,7,8−HxCDF
1,2,3,6,7,8−HxCDF
1,2,3,7,8,9−HxCDF
2,3,4,6,7,8−HxCDF
1,2,3,4,6,7,8−HpCDF
1,2,3,4,7,8,9−HpCDF
OCDF


hardhead catfish−11264
Contribution to Total (%)
0.0
0.2
0.4
0.6
0.8
1.0
2,3,7,8−TCDD
1,2,3,7,8−PeCDD
1,2,3,4,7,8−HxCDD
1,2,3,6,7,8−HxCDD
1,2,3,7,8,9−HxCDD
1,2,3,4,6,7,8−HpCDD
OCDD
2,3,7,8−TCDF
1,2,3,7,8−PeCDF
2,3,4,7,8−PeCDF
1,2,3,4,7,8−HxCDF
1,2,3,6,7,8−HxCDF
1,2,3,7,8,9−HxCDF
2,3,4,6,7,8−HxCDF
1,2,3,4,6,7,8−HpCDF
1,2,3,4,7,8,9−HpCDF
OCDF

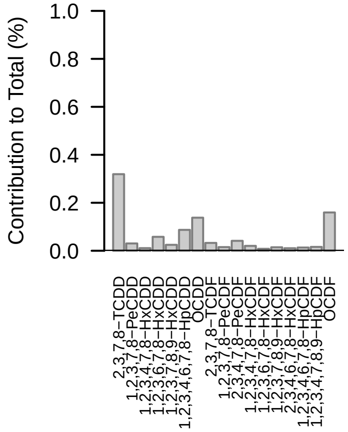

hardhead catfish−11264
Contribution to Total (%)
0.0
0.2
0.4
0.6
0.8
1.0
2,3,7,8−TCDD
1,2,3,7,8−PeCDD
1,2,3,4,7,8−HxCDD
1,2,3,6,7,8−HxCDD
1,2,3,7,8,9−HxCDD
1,2,3,4,6,7,8−HpCDD
OCDD
2,3,7,8−TCDF
1,2,3,7,8−PeCDF
2,3,4,7,8−PeCDF
1,2,3,4,7,8−HxCDF
1,2,3,6,7,8−HxCDF
1,2,3,7,8,9−HxCDF
2,3,4,6,7,8−HxCDF
1,2,3,4,6,7,8−HpCDF
1,2,3,4,7,8,9−HpCDF
OCDF


hardhead catfish−11265
Contribution to Total (%)
0.0
0.2
0.4
0.6
0.8
1.0
2,3,7,8−TCDD
1,2,3,7,8−PeCDD
1,2,3,4,7,8−HxCDD
1,2,3,6,7,8−HxCDD
1,2,3,7,8,9−HxCDD
1,2,3,4,6,7,8−HpCDD
OCDD
2,3,7,8−TCDF
1,2,3,7,8−PeCDF
2,3,4,7,8−PeCDF
1,2,3,4,7,8−HxCDF
1,2,3,6,7,8−HxCDF
1,2,3,7,8,9−HxCDF
2,3,4,6,7,8−HxCDF
1,2,3,4,6,7,8−HpCDF
1,2,3,4,7,8,9−HpCDF
OCDF

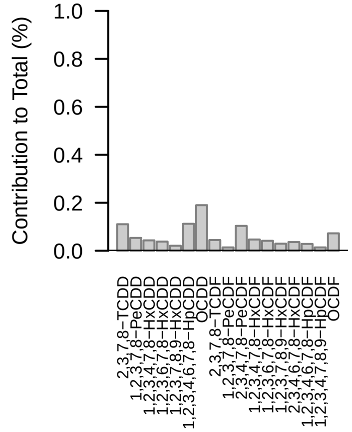

hardhead catfish−11270
Contribution to Total (%)
0.0
0.2
0.4
0.6
0.8
1.0
2,3,7,8−TCDD
1,2,3,7,8−PeCDD
1,2,3,4,7,8−HxCDD
1,2,3,6,7,8−HxCDD
1,2,3,7,8,9−HxCDD
1,2,3,4,6,7,8−HpCDD
OCDD
2,3,7,8−TCDF
1,2,3,7,8−PeCDF
2,3,4,7,8−PeCDF
1,2,3,4,7,8−HxCDF
1,2,3,6,7,8−HxCDF
1,2,3,7,8,9−HxCDF
2,3,4,6,7,8−HxCDF
1,2,3,4,6,7,8−HpCDF
1,2,3,4,7,8,9−HpCDF
OCDF


hardhead catfish−11270
hardhead catfish−11270
hardhead catfish−11273
hardhead catfish−11273
hardhead catfish−11273
hardhead catfish−11280
hardhead catfish−11280
hardhead catfish−11280
hardhead catfish−11280
Contribution to Total (%)
1.0
0.8
0.6
0.4
0.2
0.0
2,3,7,8−TCDD
1,2,3,7,8−PeCDD
1,2,3,4,7,8−HxCDD
1,2,3,6,7,8−HxCDD
1,2,3,7,8,9−HxCDD
1,2,3,4,6,7,8−HpCDD
OCDD
2,3,7,8−TCDF
1,2,3,7,8−PeCDF
2,3,4,7,8−PeCDF
1,2,3,4,7,8−HxCDF
1,2,3,6,7,8−HxCDF
1,2,3,7,8,9−HxCDF
2,3,4,6,7,8−HxCDF
1,2,3,4,6,7,8−HpCDF
1,2,3,4,7,8,9−HpCDF
OCDF

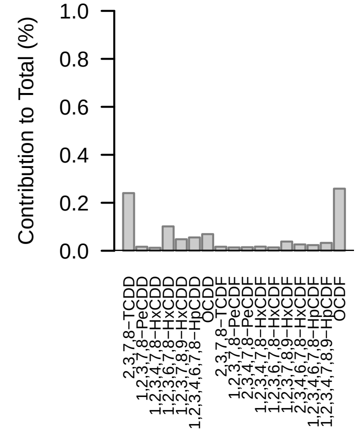
hardhead catfish−11287



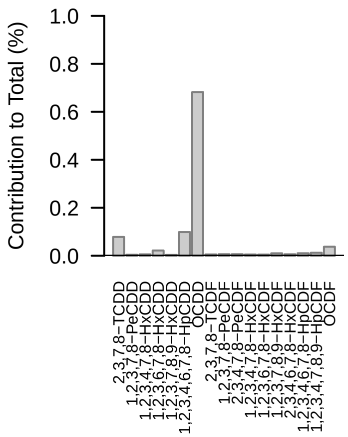
hardhead catfish−11292



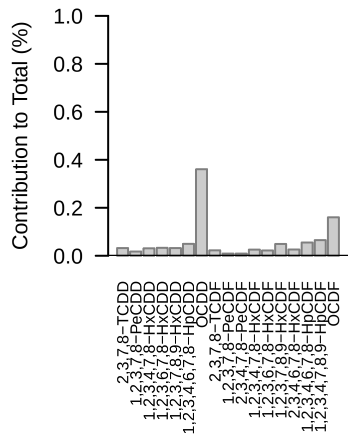
hardhead catfish−13309



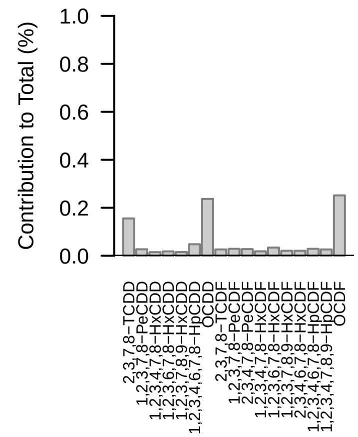
hardhead catfish−13336



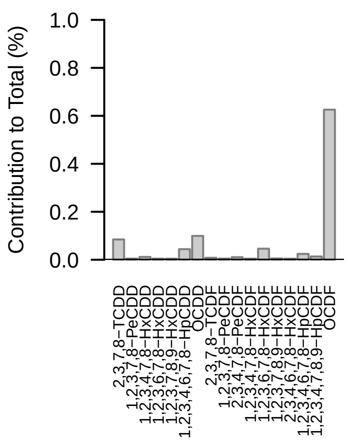
hardhead catfish−13336



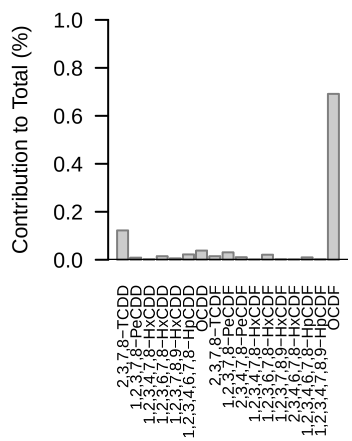
hardhead catfish−13336



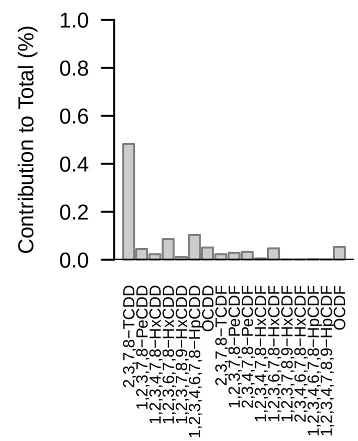
hardhead catfish−13337

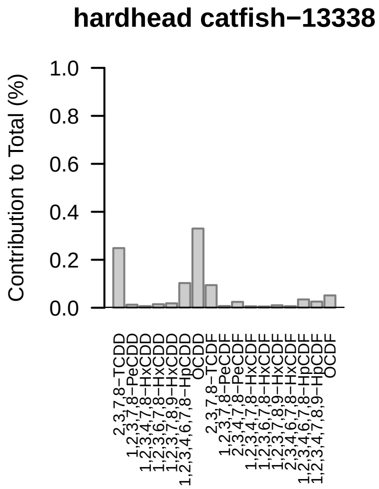


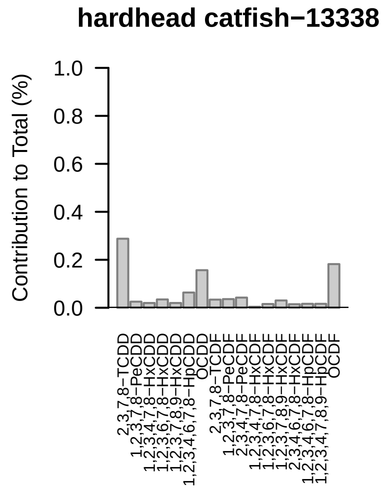
hardhead catfish−13337

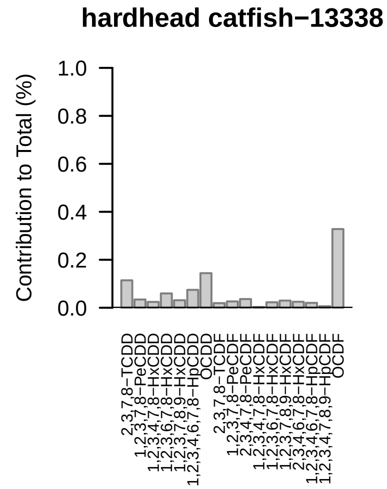


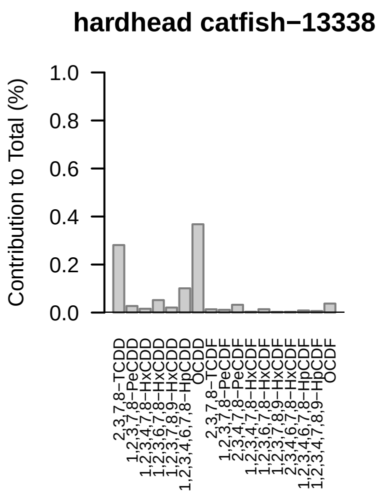
hardhead catfish−13337

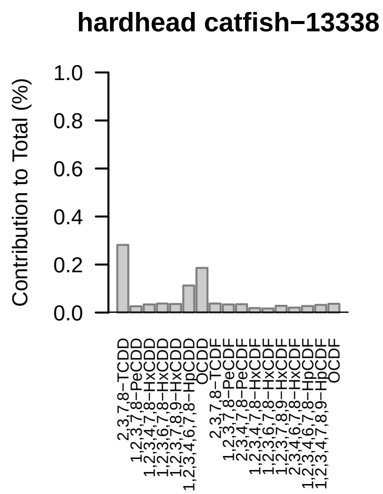


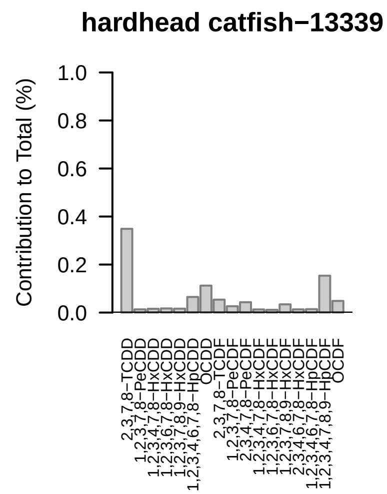

hardhead catfish−13338
Contribution to Total (%)
0.0 0.2 0.4 0.6 0.8 1.0
2,3,7,8−TCDD
1,2,3,7,8−PeCDD
1,2,3,4,7,8−HxCDD
1,2,3,6,7,8−HxCDD
1,2,3,7,8,9−HxCDD
1,2,3,4,6,7,8−HpCDD
OCDD
2,3,7,8−TCDF
1,2,3,7,8−PeCDF
2,3,4,7,8−PeCDF
1,2,3,4,7,8−HxCDF
1,2,3,6,7,8−HxCDF
1,2,3,7,8,9−HxCDF
2,3,4,6,7,8−HxCDF
1,2,3,4,6,7,8−HpCDF
1,2,3,4,7,8,9−HpCDF
OCDF

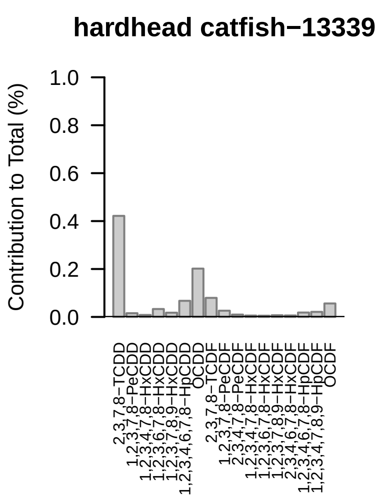

hardhead catfish−13338
Contribution to Total (%)
0.0 0.2 0.4 0.6 0.8 1.0
2,3,7,8−TCDD
1,2,3,7,8−PeCDD
1,2,3,4,7,8−HxCDD
1,2,3,6,7,8−HxCDD
1,2,3,7,8,9−HxCDD
1,2,3,4,6,7,8−HpCDD
OCDD
2,3,7,8−TCDF
1,2,3,7,8−PeCDF
2,3,4,7,8−PeCDF
1,2,3,4,7,8−HxCDF
1,2,3,6,7,8−HxCDF
1,2,3,7,8,9−HxCDF
2,3,4,6,7,8−HxCDF
1,2,3,4,6,7,8−HpCDF
1,2,3,4,7,8,9−HpCDF
OCDF

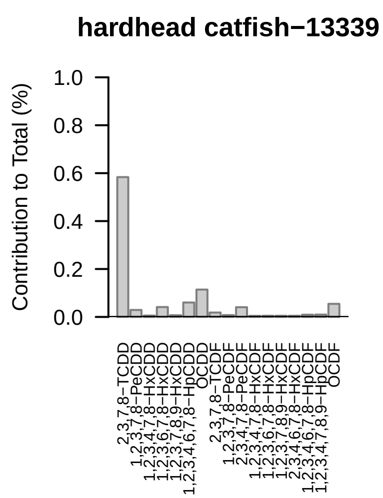

hardhead catfish−13338
Contribution to Total (%)
0.0 0.2 0.4 0.6 0.8 1.0
2,3,7,8−TCDD
1,2,3,7,8−PeCDD
1,2,3,4,7,8−HxCDD
1,2,3,6,7,8−HxCDD
1,2,3,7,8,9−HxCDD
1,2,3,4,6,7,8−HpCDD
OCDD
2,3,7,8−TCDF
1,2,3,7,8−PeCDF
2,3,4,7,8−PeCDF
1,2,3,4,7,8−HxCDF
1,2,3,6,7,8−HxCDF
1,2,3,7,8,9−HxCDF
2,3,4,6,7,8−HxCDF
1,2,3,4,6,7,8−HpCDF
1,2,3,4,7,8,9−HpCDF
OCDF

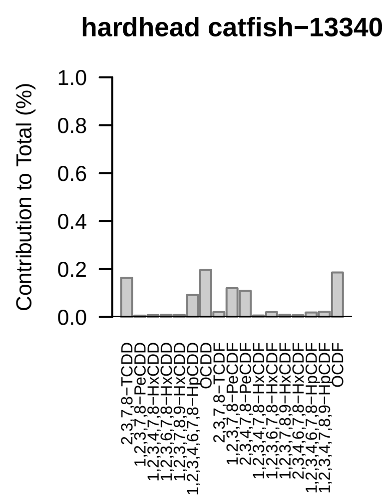

hardhead catfish−13338
Contribution to Total (%)
0.0 0.2 0.4 0.6 0.8 1.0
2,3,7,8−TCDD
1,2,3,7,8−PeCDD
1,2,3,4,7,8−HxCDD
1,2,3,6,7,8−HxCDD
1,2,3,7,8,9−HxCDD
1,2,3,4,6,7,8−HpCDD
OCDD
2,3,7,8−TCDF
1,2,3,7,8−PeCDF
2,3,4,7,8−PeCDF
1,2,3,4,7,8−HxCDF
1,2,3,6,7,8−HxCDF
1,2,3,7,8,9−HxCDF
2,3,4,6,7,8−HxCDF
1,2,3,4,6,7,8−HpCDF
1,2,3,4,7,8,9−HpCDF
OCDF

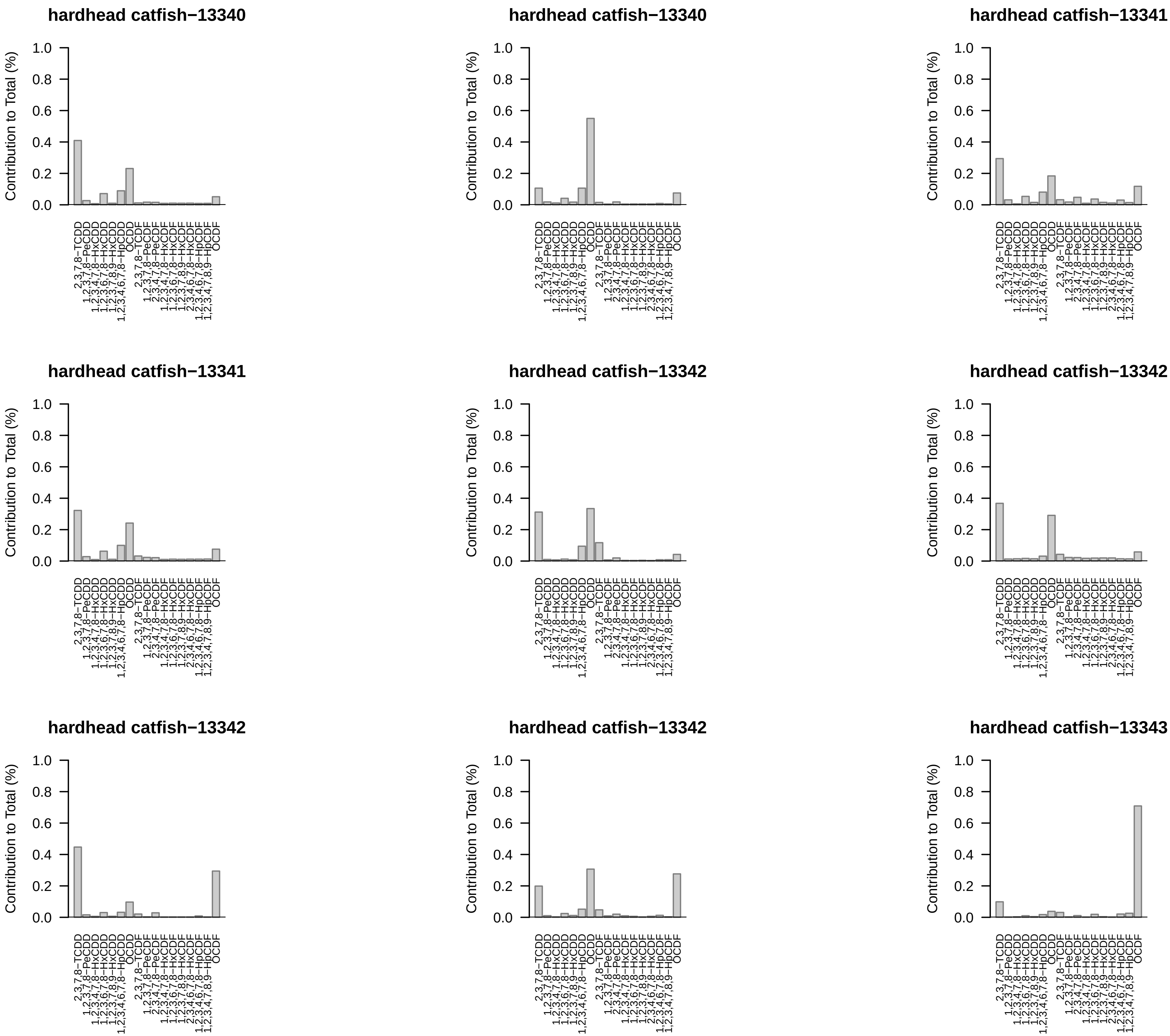

hardhead catfish−13338
Contribution to Total (%)
0.0 0.2 0.4 0.6 0.8 1.0
2,3,7,8−TCDD
1,2,3,7,8−PeCDD
1,2,3,4,7,8−HxCDD
1,2,3,6,7,8−HxCDD
1,2,3,7,8,9−HxCDD
1,2,3,4,6,7,8−HpCDD
OCDD
2,3,7,8−TCDF
1,2,3,7,8−PeCDF
2,3,4,7,8−PeCDF
1,2,3,4,7,8−HxCDF
1,2,3,6,7,8−HxCDF
1,2,3,7,8,9−HxCDF
2,3,4,6,7,8−HxCDF
1,2,3,4,6,7,8−HpCDF
1,2,3,4,7,8,9−HpCDF
OCDF

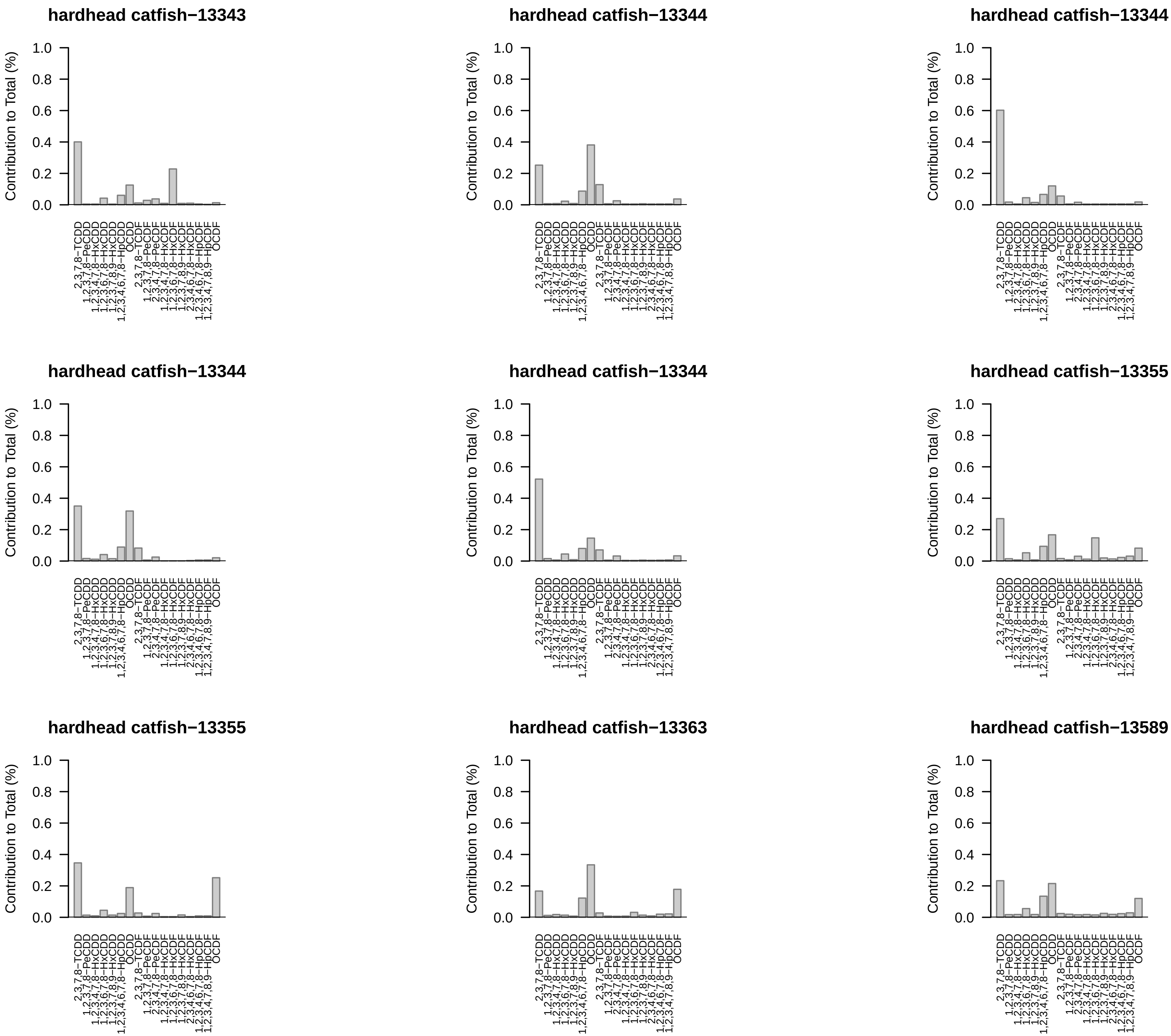

hardhead catfish−13339
Contribution to Total (%)
0.0 0.2 0.4 0.6 0.8 1.0
2,3,7,8−TCDD
1,2,3,7,8−PeCDD
1,2,3,4,7,8−HxCDD
1,2,3,6,7,8−HxCDD
1,2,3,7,8,9−HxCDD
1,2,3,4,6,7,8−HpCDD
OCDD
2,3,7,8−TCDF
1,2,3,7,8−PeCDF
2,3,4,7,8−PeCDF
1,2,3,4,7,8−HxCDF
1,2,3,6,7,8−HxCDF
1,2,3,7,8,9−HxCDF
2,3,4,6,7,8−HxCDF
1,2,3,4,6,7,8−HpCDF
1,2,3,4,7,8,9−HpCDF
OCDF

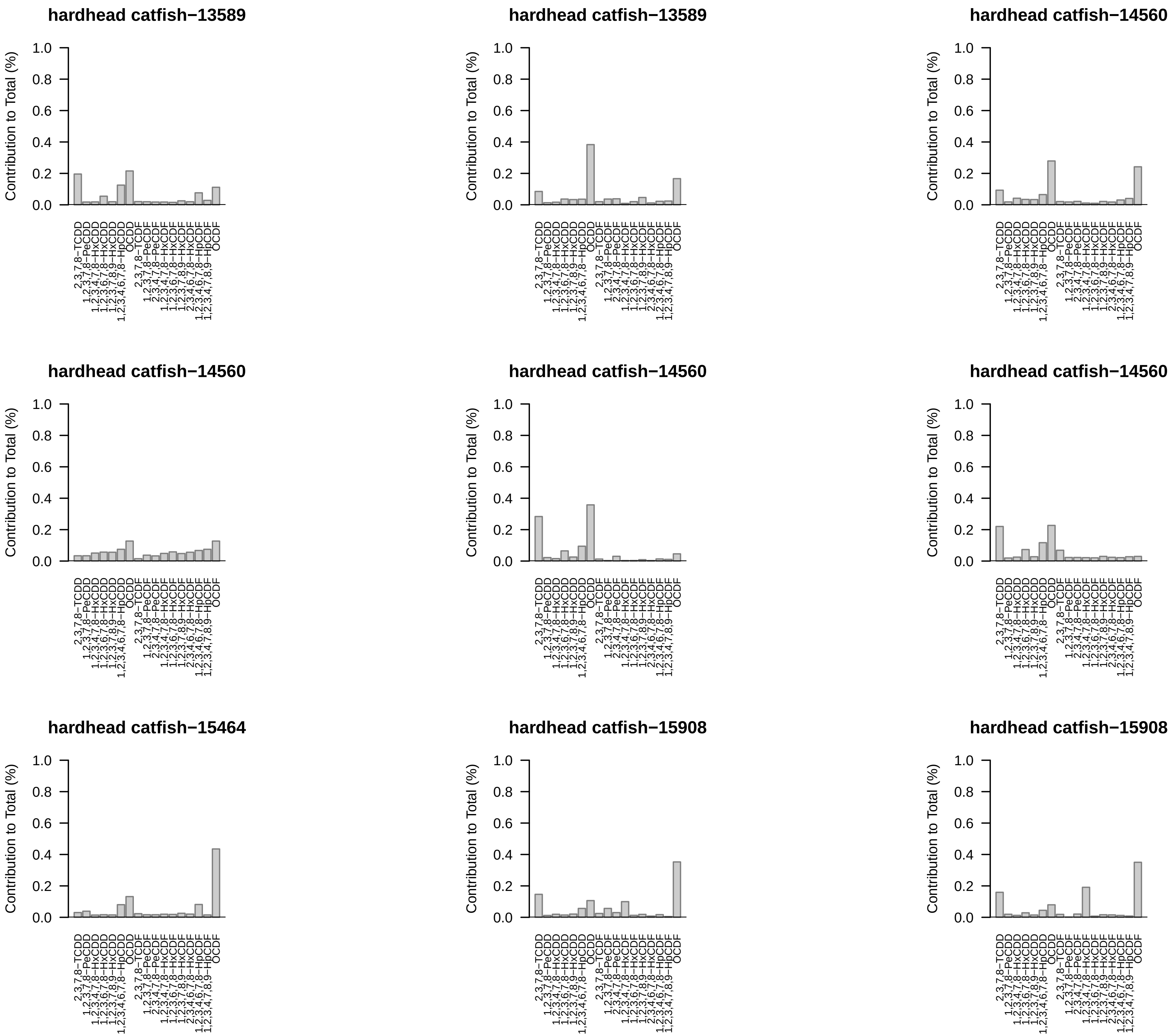

hardhead catfish−13339
Contribution to Total (%)
0.0 0.2 0.4 0.6 0.8 1.0
2,3,7,8−TCDD
1,2,3,7,8−PeCDD
1,2,3,4,7,8−HxCDD
1,2,3,6,7,8−HxCDD
1,2,3,7,8,9−HxCDD
1,2,3,4,6,7,8−HpCDD
OCDD
2,3,7,8−TCDF
1,2,3,7,8−PeCDF
2,3,4,7,8−PeCDF
1,2,3,4,7,8−HxCDF
1,2,3,6,7,8−HxCDF
1,2,3,7,8,9−HxCDF
2,3,4,6,7,8−HxCDF
1,2,3,4,6,7,8−HpCDF
1,2,3,4,7,8,9−HpCDF
OCDF

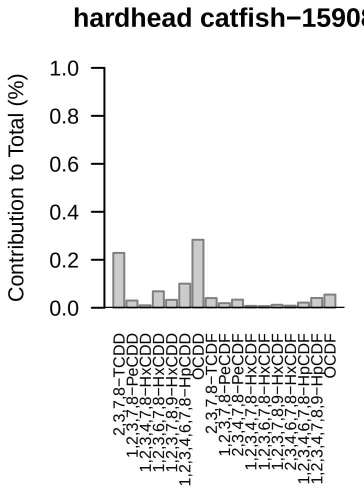

hardhead catfish−13339
Contribution to Total (%)
0.0 0.2 0.4 0.6 0.8 1.0
2,3,7,8−TCDD
1,2,3,7,8−PeCDD
1,2,3,4,7,8−HxCDD
1,2,3,6,7,8−HxCDD
1,2,3,7,8,9−HxCDD
1,2,3,4,6,7,8−HpCDD
OCDD
2,3,7,8−TCDF
1,2,3,7,8−PeCDF
2,3,4,7,8−PeCDF
1,2,3,4,7,8−HxCDF
1,2,3,6,7,8−HxCDF
1,2,3,7,8,9−HxCDF
2,3,4,6,7,8−HxCDF
1,2,3,4,6,7,8−HpCDF
1,2,3,4,7,8,9−HpCDF
OCDF

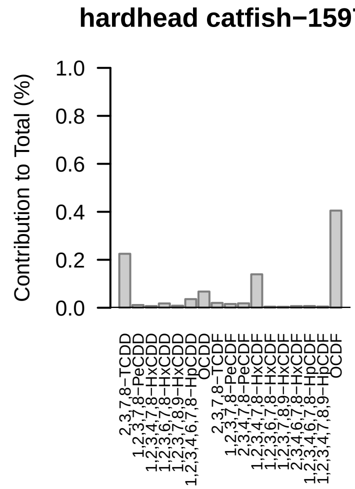

hardhead catfish−13340
Contribution to Total (%)
0.0 0.2 0.4 0.6 0.8 1.0
2,3,7,8−TCDD
1,2,3,7,8−PeCDD
1,2,3,4,7,8−HxCDD
1,2,3,6,7,8−HxCDD
1,2,3,7,8,9−HxCDD
1,2,3,4,6,7,8−HpCDD
OCDD
2,3,7,8−TCDF
1,2,3,7,8−PeCDF
2,3,4,7,8−PeCDF
1,2,3,4,7,8−HxCDF
1,2,3,6,7,8−HxCDF
1,2,3,7,8,9−HxCDF
2,3,4,6,7,8−HxCDF
1,2,3,4,6,7,8−HpCDF
1,2,3,4,7,8,9−HpCDF
OCDF

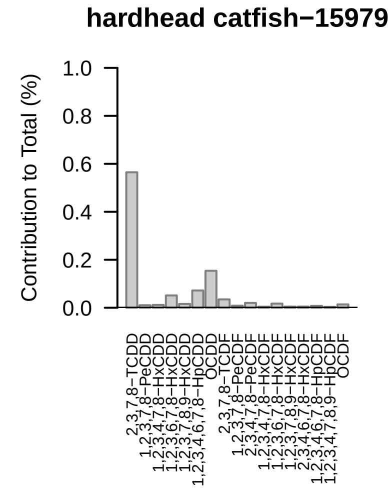

hardhead catfish−13340
hardhead catfish−13340
hardhead catfish−13341
hardhead catfish−13341
hardhead catfish−13342
hardhead catfish−13342
hardhead catfish−13342
hardhead catfish−13342
hardhead catfish−13343
Contribution to Total (%)
0.0
0.2
0.4
0.6
0.8
1.0
2,3,7,8−TCDD
1,2,3,7,8−PeCDD
1,2,3,4,7,8−HxCDD
1,2,3,6,7,8−HxCDD
1,2,3,7,8,9−HxCDD
1,2,3,4,6,7,8−HpCDD
OCDD
2,3,7,8−TCDF
1,2,3,7,8−PeCDF
2,3,4,7,8−PeCDF
1,2,3,4,7,8−HxCDF
1,2,3,6,7,8−HxCDF
1,2,3,7,8,9−HxCDF
2,3,4,6,7,8−HxCDF
1,2,3,4,6,7,8−HpCDF
1,2,3,4,7,8,9−HpCDF
OCDF

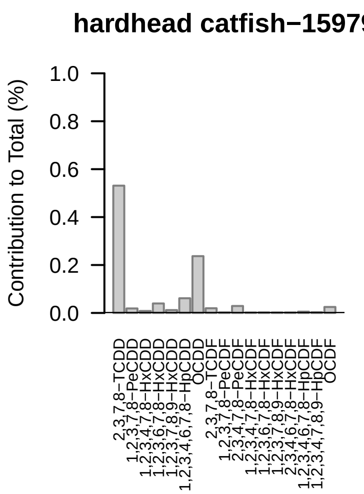

hardhead catfish−13343
hardhead catfish−13344
hardhead catfish−13344
hardhead catfish−13344
hardhead catfish−13344
hardhead catfish−13355
hardhead catfish−13355
hardhead catfish−13363
hardhead catfish−13589
Contribution to Total (%)
2,3,7,8−TCDD
1,2,3,7,8−PeCDD
1,2,3,4,7,8−HxCDD
1,2,3,6,7,8−HxCDD
1,2,3,7,8,9−HxCDD
1,2,3,4,6,7,8−HpCDD
OCDD
2,3,7,8−TCDF
1,2,3,7,8−PeCDF
2,3,4,7,8−PeCDF
1,2,3,4,7,8−HxCDF
1,2,3,6,7,8−HxCDF
1,2,3,7,8,9−HxCDF
2,3,4,6,7,8−HxCDF
1,2,3,4,6,7,8−HpCDF
1,2,3,4,7,8,9−HpCDF
OCDF

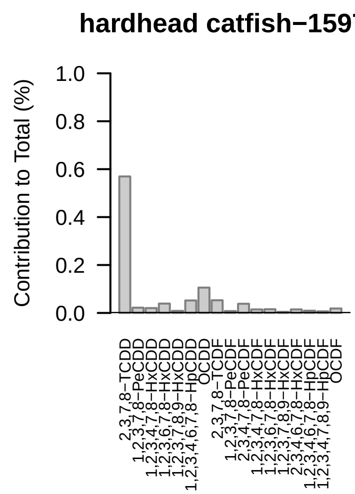

hardhead catfish−13589
hardhead catfish−13589
hardhead catfish−14560
hardhead catfish−14560
hardhead catfish−14560
hardhead catfish−14560
hardhead catfish−15464
hardhead catfish−15908
hardhead catfish−15908
Contribution to Total (%)
0.0
0.2
0.4
0.6
0.8
1.0
2,3,7,8−TCDD
1,2,3,7,8−PeCDD
1,2,3,4,7,8−HxCDD
1,2,3,6,7,8−HxCDD
1,2,3,7,8,9−HxCDD
1,2,3,4,6,7,8−HpCDD
OCDD
2,3,7,8−TCDF
1,2,3,7,8−PeCDF
2,3,4,7,8−PeCDF
1,2,3,4,7,8−HxCDF
1,2,3,6,7,8−HxCDF
1,2,3,7,8,9−HxCDF
2,3,4,6,7,8−HxCDF
1,2,3,4,6,7,8−HpCDF
1,2,3,4,7,8,9−HpCDF
OCDF

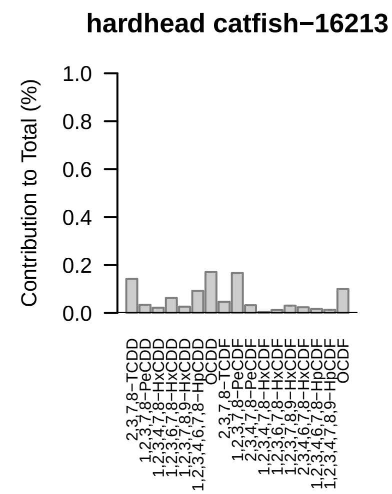

hardhead catfish−15908
Contribution to Total (%)
1.0 0.8 0.6 0.4 0.2 0.0
2,3,7,8−TCDD 1,2,3,7,8−PeCDD 1,2,3,4,7,8−HxCDD 1,2,3,6,7,8−HxCDD 1,2,3,7,8,9−HxCDD 1,2,3,4,6,7,8−HpCDD OCDD 2,3,7,8−TCDF 1,2,3,7,8−PeCDF 2,3,4,7,8−PeCDF 1,2,3,4,7,8−HxCDF 1,2,3,6,7,8−HxCDF 1,2,3,7,8,9−HxCDF 2,3,4,6,7,8−HxCDF 1,2,3,4,6,7,8−HpCDF 1,2,3,4,7,8,9−HpCDF OCDF

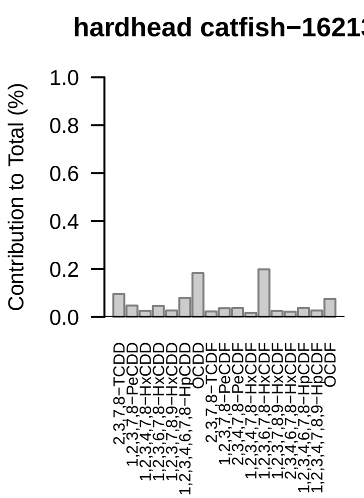

hardhead catfish−15979
Contribution to Total (%)
1.0 0.8 0.6 0.4 0.2 0.0
2,3,7,8−TCDD 1,2,3,7,8−PeCDD 1,2,3,4,7,8−HxCDD 1,2,3,6,7,8−HxCDD 1,2,3,7,8,9−HxCDD 1,2,3,4,6,7,8−HpCDD OCDD 2,3,7,8−TCDF 1,2,3,7,8−PeCDF 2,3,4,7,8−PeCDF 1,2,3,4,7,8−HxCDF 1,2,3,6,7,8−HxCDF 1,2,3,7,8,9−HxCDF 2,3,4,6,7,8−HxCDF 1,2,3,4,6,7,8−HpCDF 1,2,3,4,7,8,9−HpCDF OCDF

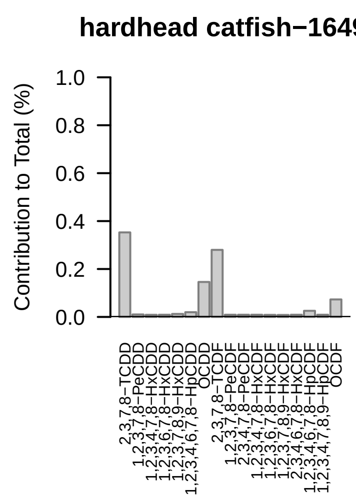

hardhead catfish−15979
Contribution to Total (%)
1.0 0.8 0.6 0.4 0.2 0.0
2,3,7,8−TCDD 1,2,3,7,8−PeCDD 1,2,3,4,7,8−HxCDD 1,2,3,6,7,8−HxCDD 1,2,3,7,8,9−HxCDD 1,2,3,4,6,7,8−HpCDD OCDD 2,3,7,8−TCDF 1,2,3,7,8−PeCDF 2,3,4,7,8−PeCDF 1,2,3,4,7,8−HxCDF 1,2,3,6,7,8−HxCDF 1,2,3,7,8,9−HxCDF 2,3,4,6,7,8−HxCDF 1,2,3,4,6,7,8−HpCDF 1,2,3,4,7,8,9−HpCDF OCDF

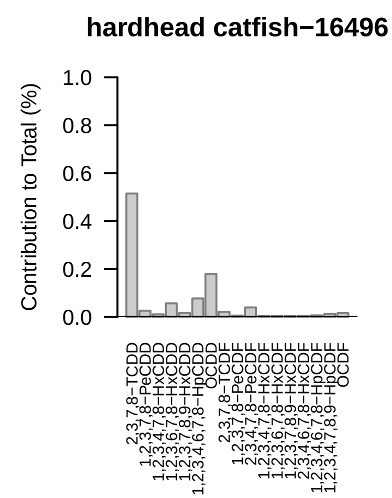

hardhead catfish−15979
Contribution to Total (%)
1.0 0.8 0.6 0.4 0.2 0.0
2,3,7,8−TCDD 1,2,3,7,8−PeCDD 1,2,3,4,7,8−HxCDD 1,2,3,6,7,8−HxCDD 1,2,3,7,8,9−HxCDD 1,2,3,4,6,7,8−HpCDD OCDD 2,3,7,8−TCDF 1,2,3,7,8−PeCDF 2,3,4,7,8−PeCDF 1,2,3,4,7,8−HxCDF 1,2,3,6,7,8−HxCDF 1,2,3,7,8,9−HxCDF 2,3,4,6,7,8−HxCDF 1,2,3,4,6,7,8−HpCDF 1,2,3,4,7,8,9−HpCDF OCDF

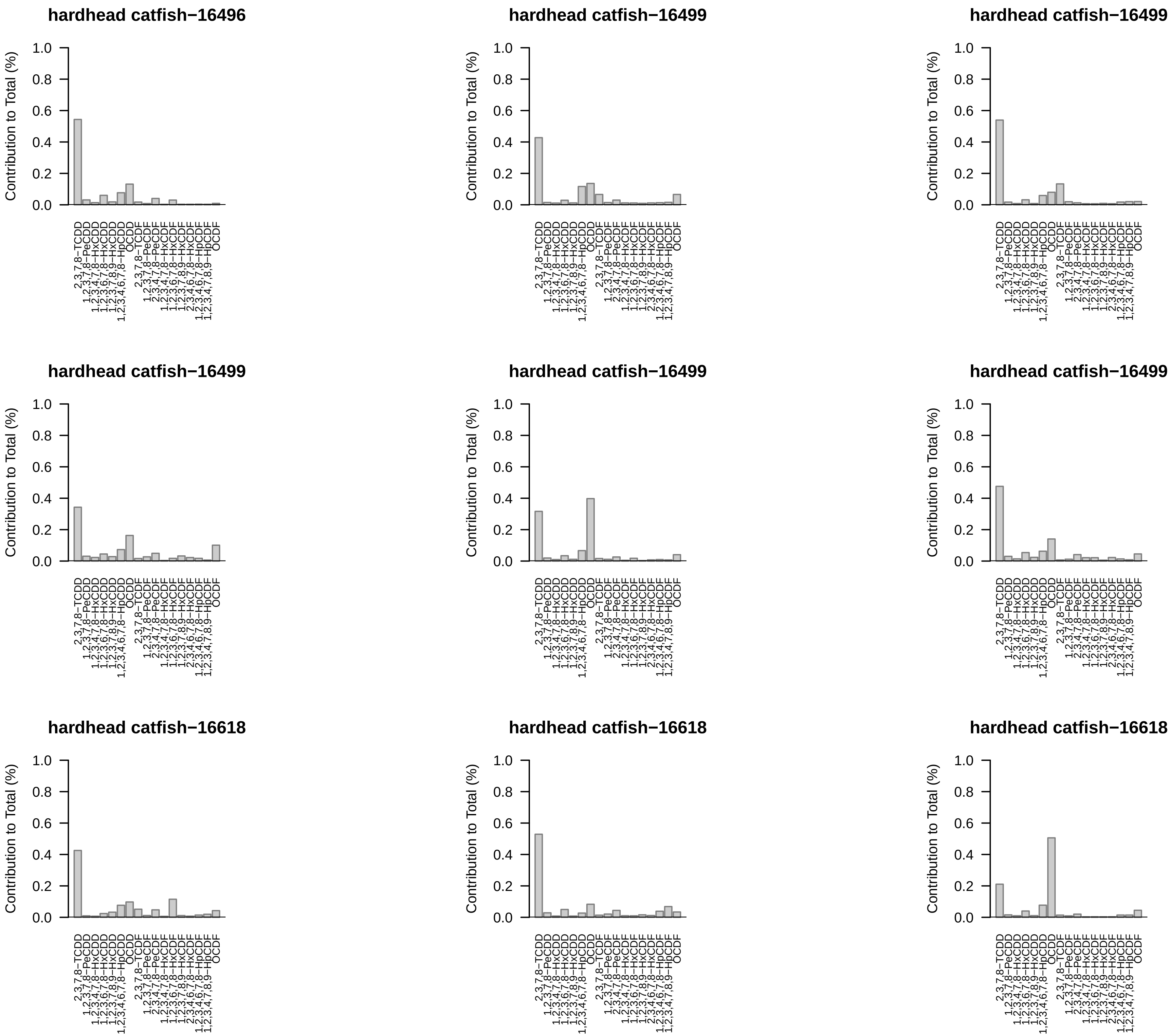

hardhead catfish−15979
Contribution to Total (%)
1.0 0.8 0.6 0.4 0.2 0.0
2,3,7,8−TCDD 1,2,3,7,8−PeCDD 1,2,3,4,7,8−HxCDD 1,2,3,6,7,8−HxCDD 1,2,3,7,8,9−HxCDD 1,2,3,4,6,7,8−HpCDD OCDD 2,3,7,8−TCDF 1,2,3,7,8−PeCDF 2,3,4,7,8−PeCDF 1,2,3,4,7,8−HxCDF 1,2,3,6,7,8−HxCDF 1,2,3,7,8,9−HxCDF 2,3,4,6,7,8−HxCDF 1,2,3,4,6,7,8−HpCDF 1,2,3,4,7,8,9−HpCDF OCDF

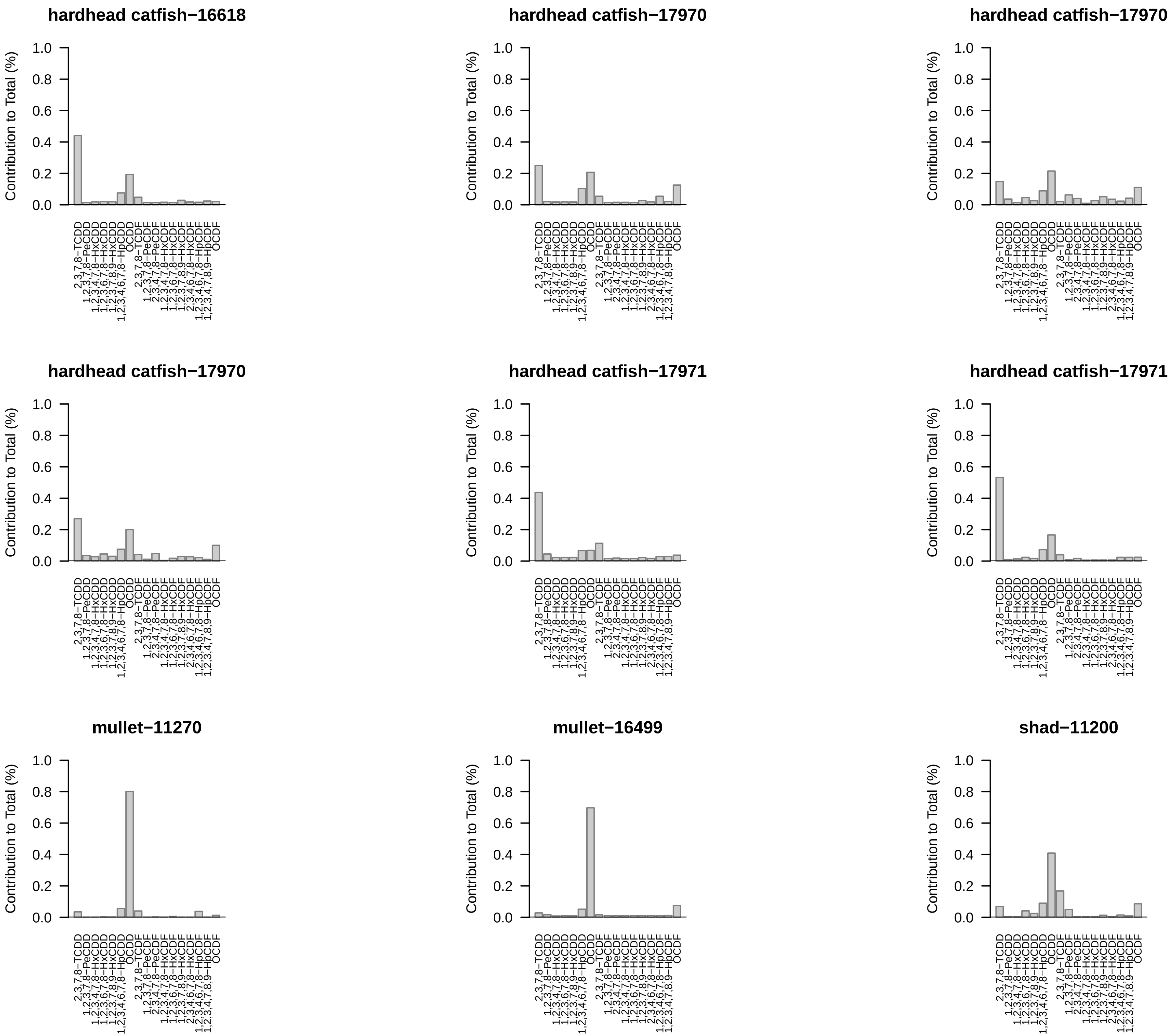

hardhead catfish−16213
Contribution to Total (%)
1.0 0.8 0.6 0.4 0.2 0.0
2,3,7,8−TCDD 1,2,3,7,8−PeCDD 1,2,3,4,7,8−HxCDD 1,2,3,6,7,8−HxCDD 1,2,3,7,8,9−HxCDD 1,2,3,4,6,7,8−HpCDD OCDD 2,3,7,8−TCDF 1,2,3,7,8−PeCDF 2,3,4,7,8−PeCDF 1,2,3,4,7,8−HxCDF 1,2,3,6,7,8−HxCDF 1,2,3,7,8,9−HxCDF 2,3,4,6,7,8−HxCDF 1,2,3,4,6,7,8−HpCDF 1,2,3,4,7,8,9−HpCDF OCDF

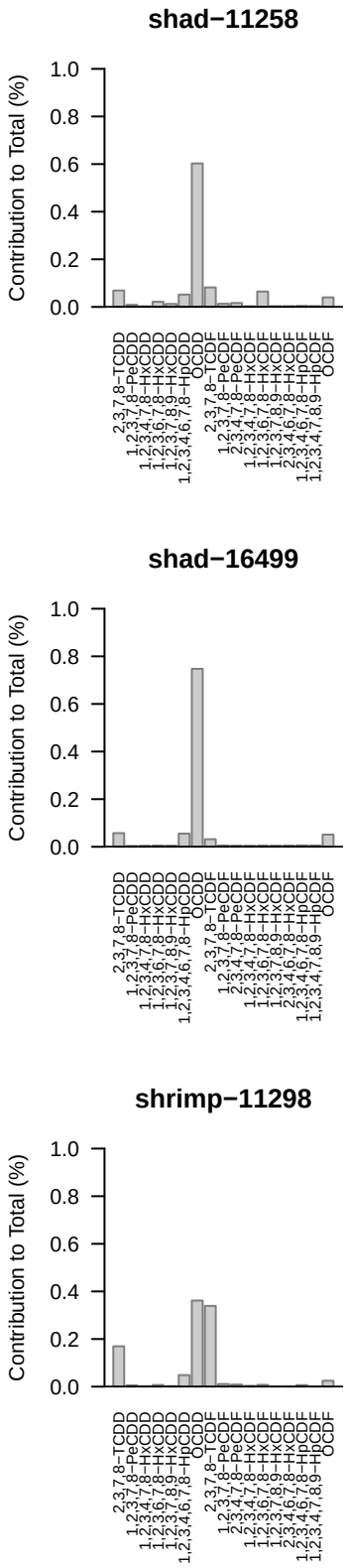

hardhead catfish−16213
Contribution to Total (%)
1.0 0.8 0.6 0.4 0.2 0.0
2,3,7,8−TCDD 1,2,3,7,8−PeCDD 1,2,3,4,7,8−HxCDD 1,2,3,6,7,8−HxCDD 1,2,3,7,8,9−HxCDD 1,2,3,4,6,7,8−HpCDD OCDD 2,3,7,8−TCDF 1,2,3,7,8−PeCDF 2,3,4,7,8−PeCDF 1,2,3,4,7,8−HxCDF 1,2,3,6,7,8−HxCDF 1,2,3,7,8,9−HxCDF 2,3,4,6,7,8−HxCDF 1,2,3,4,6,7,8−HpCDF 1,2,3,4,7,8,9−HpCDF OCDF

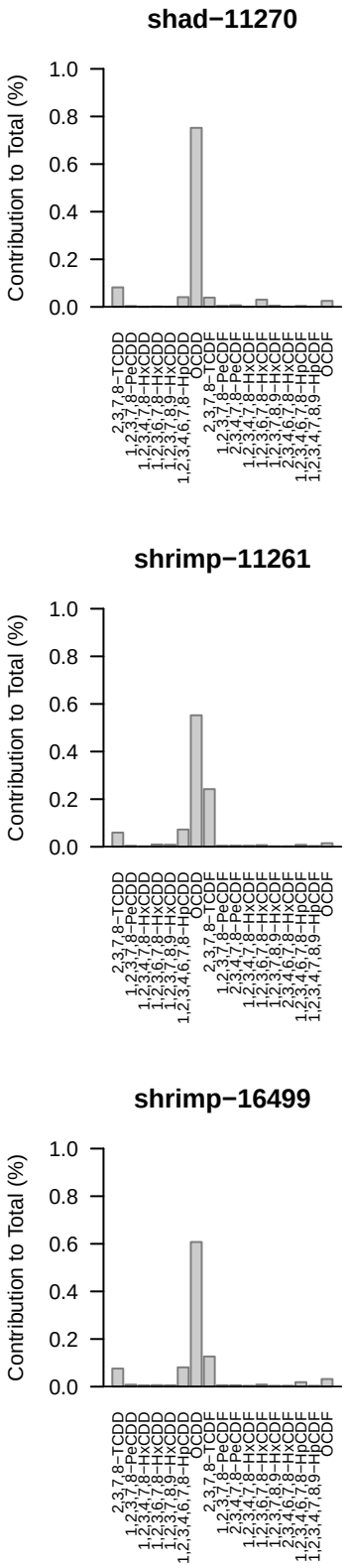

hardhead catfish−16496
Contribution to Total (%)
1.0 0.8 0.6 0.4 0.2 0.0
2,3,7,8−TCDD 1,2,3,7,8−PeCDD 1,2,3,4,7,8−HxCDD 1,2,3,6,7,8−HxCDD 1,2,3,7,8,9−HxCDD 1,2,3,4,6,7,8−HpCDD OCDD 2,3,7,8−TCDF 1,2,3,7,8−PeCDF 2,3,4,7,8−PeCDF 1,2,3,4,7,8−HxCDF 1,2,3,6,7,8−HxCDF 1,2,3,7,8,9−HxCDF 2,3,4,6,7,8−HxCDF 1,2,3,4,6,7,8−HpCDF 1,2,3,4,7,8,9−HpCDF OCDF

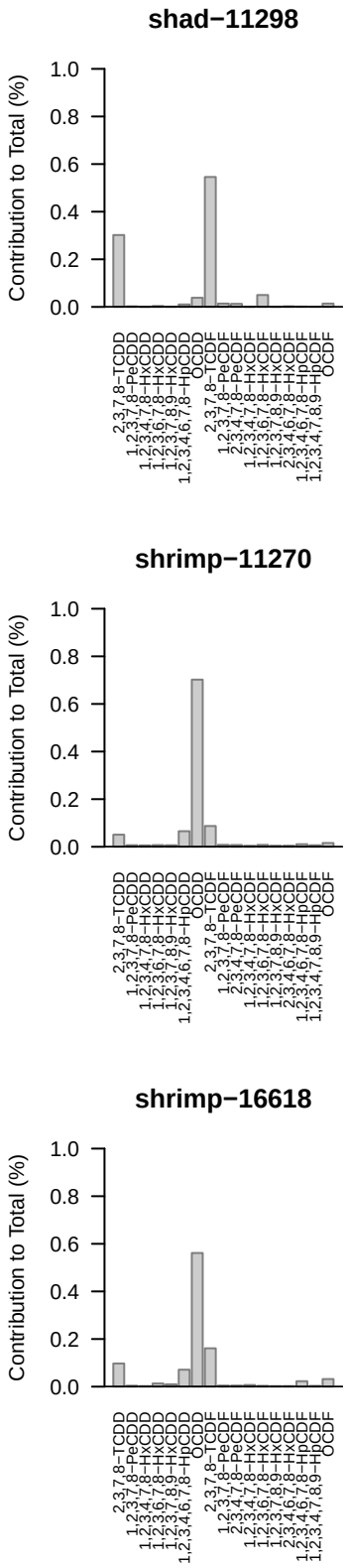

hardhead catfish−16496
Contribution to Total (%)
1.0 0.8 0.6 0.4 0.2 0.0
2,3,7,8−TCDD 1,2,3,7,8−PeCDD 1,2,3,4,7,8−HxCDD 1,2,3,6,7,8−HxCDD 1,2,3,7,8,9−HxCDD 1,2,3,4,6,7,8−HpCDD OCDD 2,3,7,8−TCDF 1,2,3,7,8−PeCDF 2,3,4,7,8−PeCDF 1,2,3,4,7,8−HxCDF 1,2,3,6,7,8−HxCDF 1,2,3,7,8,9−HxCDF 2,3,4,6,7,8−HxCDF 1,2,3,4,6,7,8−HpCDF 1,2,3,4,7,8,9−HpCDF OCDF


hardhead catfish−16496
hardhead catfish−16499
hardhead catfish−16499
hardhead catfish−16499
hardhead catfish−16499
hardhead catfish−16499
hardhead catfish−16618
hardhead catfish−16618
hardhead catfish−16618
Contribution to Total (%)
0.0
0.2
0.4
0.6
0.8
1.0
2,3,7,8−TCDD
1,2,3,7,8−PeCDD
1,2,3,4,7,8−HxCDD
1,2,3,6,7,8−HxCDD
1,2,3,7,8,9−HxCDD
1,2,3,4,6,7,8−HpCDD
OCDD
2,3,7,8−TCDF
1,2,3,7,8−PeCDF
2,3,4,7,8−PeCDF
1,2,3,4,7,8−HxCDF
1,2,3,6,7,8−HxCDF
1,2,3,7,8,9−HxCDF
2,3,4,6,7,8−HxCDF
1,2,3,4,6,7,8−HpCDF
1,2,3,4,7,8,9−HpCDF
OCDF


hardhead catfish−16618
hardhead catfish−17970
hardhead catfish−17970
hardhead catfish−17970
hardhead catfish−17971
hardhead catfish−17971
mullet−11270
mullet−16499
shad−11200
Contribution to Total (%)
0.0
0.2
0.4
0.6
0.8
1.0
2,3,7,8−TCDD
1,2,3,7,8−PeCDD
1,2,3,4,7,8−HxCDD
1,2,3,6,7,8−HxCDD
1,2,3,7,8,9−HxCDD
1,2,3,4,6,7,8−HpCDD
OCDD
2,3,7,8−TCDF
1,2,3,7,8−PeCDF
2,3,4,7,8−PeCDF
1,2,3,4,7,8−HxCDF
1,2,3,6,7,8−HxCDF
1,2,3,7,8,9−HxCDF
2,3,4,6,7,8−HxCDF
1,2,3,4,6,7,8−HpCDF
1,2,3,4,7,8,9−HpCDF
OCDF


shad−11258
Contribution to Total (%)
1.0
0.8
0.6
0.4
0.2
0.0
2,3,7,8−TCDD
1,2,3,7,8−PeCDD
1,2,3,4,7,8−HxCDD
1,2,3,6,7,8−HxCDD
1,2,3,7,8,9−HxCDD
1,2,3,4,6,7,8−HpCDD
OCDD
2,3,7,8−TCDF
1,2,3,7,8−PeCDF
2,3,4,7,8−PeCDF
1,2,3,4,7,8−HxCDF
1,2,3,6,7,8−HxCDF
1,2,3,7,8,9−HxCDF
2,3,4,6,7,8−HxCDF
1,2,3,4,6,7,8−HpCDF
1,2,3,4,7,8,9−HpCDF
OCDF


shad−11270
Contribution to Total (%)
1.0
0.8
0.6
0.4
0.2
0.0
2,3,7,8−TCDD
1,2,3,7,8−PeCDD
1,2,3,4,7,8−HxCDD
1,2,3,6,7,8−HxCDD
1,2,3,7,8,9−HxCDD
1,2,3,4,6,7,8−HpCDD
OCDD
2,3,7,8−TCDF
1,2,3,7,8−PeCDF
2,3,4,7,8−PeCDF
1,2,3,4,7,8−HxCDF
1,2,3,6,7,8−HxCDF
1,2,3,7,8,9−HxCDF
2,3,4,6,7,8−HxCDF
1,2,3,4,6,7,8−HpCDF
1,2,3,4,7,8,9−HpCDF
OCDF


shad−11298
Contribution to Total (%)
1.0
0.8
0.6
0.4
0.2
0.0
2,3,7,8−TCDD
1,2,3,7,8−PeCDD
1,2,3,4,7,8−HxCDD
1,2,3,6,7,8−HxCDD
1,2,3,7,8,9−HxCDD
1,2,3,4,6,7,8−HpCDD
OCDD
2,3,7,8−TCDF
1,2,3,7,8−PeCDF
2,3,4,7,8−PeCDF
1,2,3,4,7,8−HxCDF
1,2,3,6,7,8−HxCDF
1,2,3,7,8,9−HxCDF
2,3,4,6,7,8−HxCDF
1,2,3,4,6,7,8−HpCDF
1,2,3,4,7,8,9−HpCDF
OCDF

shad−16499
Contribution to Total (%)
1.0
0.8
0.6
0.4
0.2
0.0
2,3,7,8−TCDD
1,2,3,7,8−PeCDD
1,2,3,4,7,8−HxCDD
1,2,3,6,7,8−HxCDD
1,2,3,7,8,9−HxCDD
1,2,3,4,6,7,8−HpCDD
OCDD
2,3,7,8−TCDF
1,2,3,7,8−PeCDF
2,3,4,7,8−PeCDF
1,2,3,4,7,8−HxCDF
1,2,3,6,7,8−HxCDF
1,2,3,7,8,9−HxCDF
2,3,4,6,7,8−HxCDF
1,2,3,4,6,7,8−HpCDF
1,2,3,4,7,8,9−HpCDF
OCDF

shrimp−11261
Contribution to Total (%)
1.0
0.8
0.6
0.4
0.2
0.0
2,3,7,8−TCDD
1,2,3,7,8−PeCDD
1,2,3,4,7,8−HxCDD
1,2,3,6,7,8−HxCDD
1,2,3,7,8,9−HxCDD
1,2,3,4,6,7,8−HpCDD
OCDD
2,3,7,8−TCDF
1,2,3,7,8−PeCDF
2,3,4,7,8−PeCDF
1,2,3,4,7,8−HxCDF
1,2,3,6,7,8−HxCDF
1,2,3,7,8,9−HxCDF
2,3,4,6,7,8−HxCDF
1,2,3,4,6,7,8−HpCDF
1,2,3,4,7,8,9−HpCDF
OCDF

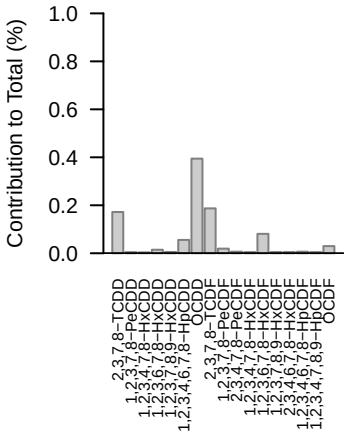
shrimp−11270
Contribution to Total (%)
1.0
0.8
0.6
0.4
0.2
0.0
2,3,7,8−TCDD
1,2,3,7,8−PeCDD
1,2,3,4,7,8−HxCDD
1,2,3,6,7,8−HxCDD
1,2,3,7,8,9−HxCDD
1,2,3,4,6,7,8−HpCDD
OCDD
2,3,7,8−TCDF
1,2,3,7,8−PeCDF
2,3,4,7,8−PeCDF
1,2,3,4,7,8−HxCDF
1,2,3,6,7,8−HxCDF
1,2,3,7,8,9−HxCDF
2,3,4,6,7,8−HxCDF
1,2,3,4,6,7,8−HpCDF
1,2,3,4,7,8,9−HpCDF
OCDF

shrimp−11298
Contribution to Total (%)
1.0
0.8
0.6
0.4
0.2
0.0
2,3,7,8−TCDD
1,2,3,7,8−PeCDD
1,2,3,4,7,8−HxCDD
1,2,3,6,7,8−HxCDD
1,2,3,7,8,9−HxCDD
1,2,3,4,6,7,8−HpCDD
OCDD
2,3,7,8−TCDF
1,2,3,7,8−PeCDF
2,3,4,7,8−PeCDF
1,2,3,4,7,8−HxCDF
1,2,3,6,7,8−HxCDF
1,2,3,7,8,9−HxCDF
2,3,4,6,7,8−HxCDF
1,2,3,4,6,7,8−HpCDF
1,2,3,4,7,8,9−HpCDF
OCDF

shrimp−16499
Contribution to Total (%)
1.0
0.8
0.6
0.4
0.2
0.0
2,3,7,8−TCDD
1,2,3,7,8−PeCDD
1,2,3,4,7,8−HxCDD
1,2,3,6,7,8−HxCDD
1,2,3,7,8,9−HxCDD
1,2,3,4,6,7,8−HpCDD
OCDD
2,3,7,8−TCDF
1,2,3,7,8−PeCDF
2,3,4,7,8−PeCDF
1,2,3,4,7,8−HxCDF
1,2,3,6,7,8−HxCDF
1,2,3,7,8,9−HxCDF
2,3,4,6,7,8−HxCDF
1,2,3,4,6,7,8−HpCDF
1,2,3,4,7,8,9−HpCDF
OCDF

shrimp−16618
Contribution to Total (%)
1.0
0.8
0.6
0.4
0.2
0.0
2,3,7,8−TCDD
1,2,3,7,8−PeCDD
1,2,3,4,7,8−HxCDD
1,2,3,6,7,8−HxCDD
1,2,3,7,8,9−HxCDD
1,2,3,4,6,7,8−HpCDD
OCDD
2,3,7,8−TCDF
1,2,3,7,8−PeCDF
2,3,4,7,8−PeCDF
1,2,3,4,7,8−HxCDF
1,2,3,6,7,8−HxCDF
1,2,3,7,8,9−HxCDF
2,3,4,6,7,8−HxCDF
1,2,3,4,6,7,8−HpCDF
1,2,3,4,7,8,9−HpCDF
OCDF

silverside minnow−11270



silverside minnow−16499